THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL

VOL. 61 Thursday, September 14, 1939 No 1204

PUBLISHED WEEKLY

Subscription Terms: 17s. 6d. per annum.
Foreign and Colonial: 20s. per annum.
All Subscriptions are payable in advance.

All Communications to be addressed to the Editor, the Advertisement Manager, or the Publisher of

THE FOUNDRY TRADE JOURNAL
49, Wellington Street, London, W.C.2.

Emergency Address:
3, Amersham Road, HIGH WYCOMBE, Bucks.
Telegraphic Address: "Zacatecas, High Wycombe."
Telephone: HIGH WYCOMBE 1792 (3 lines).

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF

The Institute of British Foundrymen

The Institute of Vitreous Enamellers

The Welsh Engineers' and Founders' Association

The Foundry Trades' Equipment and Supplies Association

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Education for Industry

We have previously confessed that our views on the education and training of the personnel for the foundry industry have not been consistent. If justification be needed, it is to be found in the address which Dr. A. P. Fleming gave to the annual meeting of the British Association. Here are two of his statements:—(1) "Developments in the organisation of industry produced new educational needs and created a demand for personnel capable of filling a wide range of positions—for each of which special training was required." (2) "The evolution of industry involved a continual change in the character of the knowledge that must be applied by those engaged in it in order to achieve efficiency of production." It is because of these changing requirements that our policy has not been static. Some fifteen years ago, we were stressing the need for the more general introduction of the metallurgist into the industry. A decade later we were pleading for special university courses for the adequate training of these scientists, and this resulted in the institution of a degree course at Sheffield. Simultaneously, we made propaganda for creating facilities for promising foundry metallurgists and highly-skilled operatives to receive, side by side, co-ordinated courses of instruction designed to impart essential knowledge not easily acquired by normal routine methods. The effort bore fruit in the creation of the British Foundry School.

A few years ago, we objected to the wholesale marshalling of the apprentices and other youngsters to evening technical classes, believing that it would (1) tend to lower the average standard; (2) damp the enthusiasm of the keener ones; (3) reduce the capacity for acquiring general knowledge, which forms the background of character; and (4) preclude young men from following their natural instincts and ambitions, such as are catered for by the Boy Scout movement and sundry youth organisations. We think we find some support for this contention in Dr. Fleming's address, for he says: "Selected men should be given preliminary and widely applied responsibility before any use was made of such aids as the ancillary instruction now available in many technical institutions." It does seem wise to have clear indications that a lad possesses the virtue of leadership before risking either personal or the country's money on instilling into him advanced knowledge which he shows but little promise of effectively using. Thus, it seems that an effort must be made to differentiate between those who are merely good at passing examinations and those who exhibit at an early age the gift of leadership and resource.

This constantly changing make-up of industry and the creation of new industries demand above all the qualities of resource. A young moulder who has specialised in chemistry and metallurgy still requires many additional attributes if he is to be a successful manager of a mechanised plant. Recently we referred to the dearth of men who would take full responsibility for the conduct of making the largest types of castings. Here the pre-requisites are a long and sound experience of practical moulding, leadership, resource and courage, together with a conviction that co-operation with the metallurgist is to-day an essential.

There is too little appreciation by the educational authorities that the apprentice in the foundry and similar industries requires a much better general knowledge than elementary education has given him, before it becomes necessary to reinforce his technical background. The university graduate generally, but not always, has acquired this during his period of training by social contact with students from other faculties. It should be the aim of the industrial and the educational authorities to find an equivalent for this mind-broadening experience, notably gained at the older universities. If bounded by industrial limits, the effort made by the British Foundry School is in this direction, for the practician and the theorist are not only placed in close contact for twelve months, but through their lecturers they make contact with many recognised leaders of thought within the industry.

Finally, it is obvious that closer and individual attention must be paid to the apprentices, and to ascertain their worth, leadership tests of a constantly varying character should be imposed and the results they give acted upon to promote the utmost encouragement to those showing initiative.

Economical Operation of Compressed-Air Plant

By D. T. ANDERTON, B.Sc.

It is well worth while in many foundries and enamelling shops to check up periodically over the compressed-air system. Apart from the actual faults which develop and which may be corrected periodically, it is often found that, owing to expansion of plant or changes in operations, the piping, etc., originally installed becomes inadequate for present demands. Periodic check-ups will help to minimise the inefficiency which such a situation entails. There is another aspect also. Compressed-air systems are sometimes considered as inherently wasteful, and there is consequently a tendency to adopt the attitude that little can be done to improve matters. Such a policy of drift will in any case allow things gradually to deteriorate, since ordinary maintenance attention is liable to be neglected. Much can be done on the average compressed-air system to economise by attention to a number of points.

Influence of Intake Temperature

A simple point which is sometimes overlooked is the location of the air intake. An unsuitable position for the intake can substantially increase operating costs, for the following reason. The average temperature of the outside air is considerably below that in buildings, and placing the compressor intake outside results in increased compressor capacity and efficiency.

Assume, for instance, that the average indoor temperature (at which the air will be used) is 60 deg. Fah. If the intake is from air at this temperature, it will be heated during compression, but during its travel to the point of use the air will cool back to the room temperature. Under these conditions, if 1,000 cub. ft. of air are taken into the compressor in a given time, 1,000 cub. ft. will be delivered at the point of use. On the other hand, if the intake receives air from the exterior of a building at (say) 45 deg. Fah., only 971 cub. ft. will now be required to deliver 1,000 cub. ft. at room temperature. There is a gain of 3 per cent. in efficiency. Naturally, the reverse is the case if the compressor is supplied from an engine room where the temperature is (say) 90 deg. Fah., since 1,056 cub. ft. of air will be required to deliver 1,000 cub. ft. at 60 deg. Fah.

The gain due to this factor is summarised in Table I, which shows that a saving of about 1 per cent. is possible for every drop of 5 deg. in temperature. The actual saving in power costs depends on local electricity charges, local installation conditions, etc. A 3,000 cub. ft. compressor operating at 100-lb. pressure, and originally receiving air from an engine room at about 85 deg. Fah., saved power amounting to over £200 per annum when the intake was removed to outside the building to reach air at an average temperature of 60 deg. Fah. (the air was used in shops at about 70 deg. Fah.). The expense of moving the intake pipe is practically the only cost involved.

TABLE I.—*Effect of Intake Temperature on Efficiency and Capacity of Air Compressors*

Initial temp. Deg. Fah.	Relative capacities and efficiencies.	Initial temp. Deg. Fah.	Relative capacities and efficiencies.
—20	1·182	70	0·981
—10	1·155	80	0·963
0	1·130	90	0·945
10	1·105	100	0·928
20	1·083	110	0·912
30	1·060	120	0·897
40	1·040	130	0·882
50	1·020	140	0·867
60	1·000	150	0·853

Air intakes should have an area at least 50 per cent. greater than the area of the air intake duct, and the duct should never be smaller than the opening on the compressor. The longer the duct, the more desirable is ample area. If the pipe is unduly long, its diameter may advantageously be increased by 1 in. for every 10 ft. in length; but it is better to keep the intake as short and direct as possible. Occasionally, trouble is experienced with air pulsation in the intake piping, the result being a tendency to supercharge the compressor. The remedy is to shorten or lengthen the intake, or sometimes to increase the diameter. In one case, substantial overloading of motor equipment occurred due to this trouble, but it was only personal observation of the compressor ammeter before and after shortening the intake which convinced the owner of the compressor that this (and not the compressor) was the real cause.

Influence of Moisture

Moisture is one of the most prolific sources of trouble and expense in compressed-air systems, and equipment for its removal should always be maintained in a thoroughly efficient condition. Before discussing such aspects, however, there are two erroneous ideas on the subject which may be pointed out. It is quite often thought that there is always more moisture getting into the air system in winter than during summer, and therefore that overhauls of traps, drains, etc., should be in preparation for the winter. This is not always true; in fact, under average conditions, the reverse is true. The moisture capacity of atmospheric air is dependent partly on the temperature, the moisture content of fully saturated air being shown graphically in Fig. 1. This gives the weight of water per 1,000 cub. ft. of air, and it will be observed that the curve rises steeply, showing that the moisture capacity is very materially influenced by the temperature. During summer, as an average, the percentage humidity of the air (*i.e.*, the percentage saturated with water vapour), as well as the air temperature, will be higher than the corresponding winter average, so that more moisture is likely to be drawn into the system during summer.

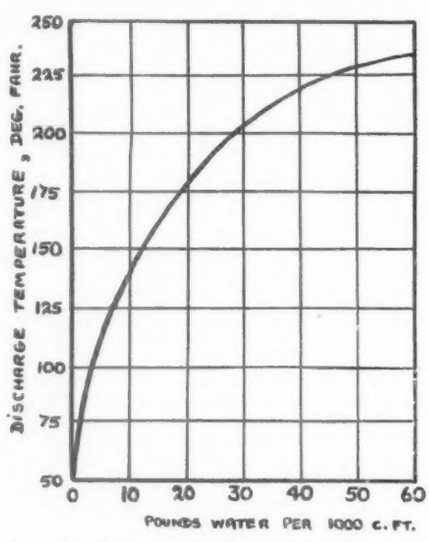


FIG. 1.—WATER CONTENT OF SATURATED AIR RELATED TO TEMPERATURE.

Fig. 1 also corrects the fallacious thought that, when freezing and other moisture troubles are prominent, a way of correcting the situation is to cut down the cooling water and so allow the air to pass out at a higher temperature. In actual fact, this simply means that more moisture is being allowed to pass out to the distribution system. Efficient cooling and efficient removal of the deposited moisture are the correct solution.

Cooling-Water Treatment

The bulk of the moisture should be removed in the compressor intercooler and the aftercooler. The latter is often like an intercooler, but placed in the line just after the air has left the compressor. The efficiency of aftercoolers and intercoolers (as well as of cylinder cooling) may be reduced by incrustation of the surfaces by impure water used for cooling. In most parts of the country, natural water supplies contain various salts which gradually accumulate as scale on the surfaces of pipes and vessels through which they pass. Scaling troubles in the case of compressor equipment are due to the thermal decomposition of the bicarbonates in the water, the heat causing the formation of the insoluble carbonates which form the bulk of the deposits. Optimum operation of the compressor, and full advantage of cooling equipment, require that this scale formation be minimised, and the surfaces cleaned of scale periodically. Sediment is also likely to collect in the lower parts of the jacket, in the intercooler heads and in low places where it is not subject to the direct flow of the water.

This scaling trouble can be overcome by a new treatment just recently developed. It consists in the addition of 2 parts per million or less of sodium metaphosphate to the cooling water supply. It has been found that even this small amount of the chemical will prevent the deposition of carbonate until a much higher concentration is reached. The treatment is successful also in removing old scale deposits, so that initial cleaning before starting the treatment is unnecessary. Such treatment is useful where an impure cooling water supply has to be used. It also may enable cheaper sources to be used. A good aftercooler design, efficiently operated, should reduce the air temperature to within about 20 deg. Fah. of the water temperature, the bulk of the moisture being removed if drainage be satisfactorily maintained.

Residual moisture which gets into the distribution system should be collected and removed by suitable trapping equipment. Mere provision of drain pots is inadequate. Some arrangement of baffles, spirals or other device is necessary, an example being illustrated in Fig. 2. The important point at which to aim is to change the direction of flow suddenly. When moisture-laden air at high velocity has to change its direction of flow, the moisture tends to be deposited, particularly if the air stream impinges on some surface in changing its direction of flow. Some such arrangement with a suitable drain is therefore needed.

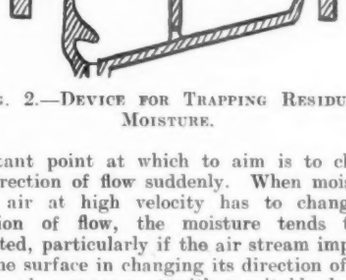


FIG. 2.—DEVICE FOR TRAPPING RESIDUAL MOISTURE.

Greasy Deposits

On the air side of the intercooler, pipes sometimes become coated with a greasy deposit; this is usually due to oil carried from the cylinder, and in addition some of the dirt and dust carried in with unscreened intake air accumulates with

the oil deposit. This also will retard heat transfer and interfere with the cooling. Lubricating-oil feeds should be maintained at that recommended by the manufacturer of the compressor; apart from this lack of cleanliness, a danger of fire or explosion is introduced when using excessive amounts of lubricant. The intake air should be filtered, too.

When the intercooler becomes fouled with oily deposits, it should not be cleaned by squirting from an oilcan a little paraffin or other spirit into the compressor suction. This is a dangerous practice, since the spirits used are readily vaporised and ignited under compressor conditions, and an explosion may easily occur. A better plan is to inject a thick fluid mixture of soft soap and water in the same way. Occasional treatment of this nature will often loosen oily dust deposits, but, of course, the real preventive measure is to filter the intake air and control the oil supply to avoid excess feeds of lubricant.

Compressed-air explosions, when they have occurred, have usually been the result of oily accumulations in receivers or elsewhere being fired by a spark or the development of high temperatures. A flinty particle in the air may raise a spark on striking somewhere, or ignition may be caused by red-hot carbon, but it is probable that the *rôle* of any dust in the air is to form (with lubricating oil—especially if oil is excessive) deposits on valve seats, etc. Full seating of valves may thus be prevented, and in the case of a discharge valve particularly this means a risk of repeated re-compressions of air, and attendant high-temperature development. The increased temperature in turn may cause accelerated oxidation of oil deposits to such an extent that spontaneous ignition occurs. This is therefore a further point in favour of suitable screening equipment for intake air. Undue oil feeds also are to be avoided. Efficient cooling will assist in combating these dangers, since at lower temperatures there will be less tendency for vaporisation of any parts of the lubricating oil. Note, too, that scale accumulation near valves may cause localised overheating and distortion.

Fusible Plug Practice

A fusible plug fitted between the compressor and the receiver will give warning of development of excessive temperature as may be caused by valve trouble. Such plugs need attention, to ensure that they remain in condition to be effective if needed. They should be cleaned regularly, since a deposit of oil on the plug (possibly in a sticky condition, and thus very liable to collect dust from the air) may build up to such an extent that the plug will fail to operate even when grossly overheated. The fusible alloy will be unable to get out.

Another point is that first-class plugs only should be fitted. It has been shown that if pouring, *i.e.*, the filling of the bores of the plugs with fusible alloy, is not very carefully carried out at the proper temperature, the alloy will probably become contaminated with various metals from the casing of the plug. With such impurities the melting point of the fusible alloy is greatly increased, and accordingly the result may be an ineffective plug. These types of failures have been observed on numerous occasions with steam boiler plugs, which have essentially the same purpose. High-quality plugs should therefore always be fitted, they should be kept as clean as possible, and renewed every two years.

Mains

A valuable aid to economy is the provision of mains of liberal proportions. A rule which is often adopted is to aim at an air velocity of not more than 25 ft. per second. It is generally realised that insufficient size of water pipes will increase the cost of pumping, but the same attitude is not always brought to bear on air transmission lines. Small pipes impose added frictional resistance and reduce terminal air pressures. For instance, if the air leaves the compressor at 90 lbs. and reaches the tools or machines at 70 lbs., this may be below their optimum operating pressure, and the result is a loss of efficiency and capacity of the machines. The frictional loss of pressure may be aggravated by accumulation of moisture in pockets, and a small pipe will often be more susceptible to such an influence. Sharp bends are undesirable for the same reason.

Other factors in favour of large-diameter pipes are that they serve to some extent as receivers and so help the compressors to meet peak loads, and also the larger pipes mean lower air velocities and therefore less carrying power for moisture, oil, dust impurities, etc. The latter therefore tend to be deposited early in the system where they do less damage than at machines and tools.

An indication of the cost of overcoming the friction of small pipes is given by the following case. A two-stage compressor operating at 125 lbs. pressure required some 210 h.p., the air being used at 95 lbs. During an overhaul of the system, pipe sizes were increased with a view to reducing the pressure margin in the distribution system. Eventually, satisfactory results were obtained with the compressor delivering at just over 100 lbs. pressure. Under the improved conditions, power requirements were about 190 h.p., which meant a saving of about 10 per cent. on the power bill—a useful economy in the case in question.

The pressure drop in an air system may be measured by comparing gauge readings at the point of consumption with that at the air receiver. Undue friction will be indicated by a large drop of pressure. It is necessary, of course, to take readings while the air is being used; otherwise the pressure will simply level itself out uniformly throughout the system. Figures for normal operation, peak loads, or any other desired operating times are useful "ammunition" for subsequent discussions on piping overhaul. Incidentally, in altering piping, it should not be overlooked that the interior surface area of small pipes in relation to their capacity is greater than in the case of larger pipes, so that the frictional loss is greater. The aggregate sectional area of a number of small pipes must therefore be greater than the area of a supply main, to allow for this. The relative capacities of air mains and branches have been tabulated by McLean as given in Table II. For example, if one wishes to find

TABLE II.—*Relative Capacities of Pipes.*

Diameter of main, ins. ..	1½	2	3	4	5	6	8	10	12
No. of 1-in. pipes ..	2·7	5·6	15·6	32	56	88	181	316	498

the number of 2-in. pipes to suit a 6-in. main, then divide 88 by 5.6 and the answer is 15 pipes. This is the number of branches of that size required to maintain the same loss as that in the supply main.

Leaks

One of the most common faults in air systems is the existence of leaks which, although often considered insignificant, are an unsuspected source of considerable expense. It is by no means unusual for leakage losses on a plant to amount to 10 per cent., and figured out on an annual basis the amount is well worth saving. The extent of the loss is indicated by the figures given in Table III for a few pressures. The cost, on a basis of a 50-hr. week, with electric power at ½d. per unit and air at 100 lbs. pressure, is as follows: $\frac{1}{16}$ in. leak, £6; ⅛ in., £22; ¼ in., £84; ½ in., £240; ¾ in., £760; 1 in., £1,360. On continuous operation the figures would obviously be much larger. However, it should be evident that as a number of small leaks can total the equivalent of (say) a single ½ in. leak, considerable losses may result from quite insignificant leakages.

Leaks may be traced to pipe joints, valves, cocks, rubber hose, and even to valves on machines or tools which cannot or have not been closed properly. They can be detected with soapy water swabbed around suspected parts, or in the case of difficult leaks a rag soaked in some distinctive smelling liquid such as amyl alcohol, oil of peppermint, etc., may be held near the air intake. The pronounced odour of the liquid will then show up the location of any leaks.

TABLE III.—*Extent of Air Leakage.*

Air pressure.	Size of leak.					
	$\frac{1}{64}$ in.	$\frac{1}{32}$ in.	$\frac{1}{16}$ in.	⅛ in.	¼ in.	½ in.
30 lbs. ..	0·16	0·63	2·5	10·0	40	161
40 lbs. ..	0·19	0·77	3·1	12·3	49	196
50 lbs. ..	0·23	0·92	3·7	14·5	58	232
60 lbs. ..	0·26	1·1	4·2	16·8	67	268
80 lbs. ..	0·33	1·33	5·3	21·2	85	340
100 lbs. ..	0·40	1·61	6·5	25·8	103	412

Note.—These figures give the cubic feet of air escaping per minute from orifices with rounded edges.

When screwed connections leak it may be due to corrosion of the joint caused by electrochemical action in the presence of condensate accumulation, or it may simply be for lack of adequate support for the pipe line. Flanged joints leak when gaskets deteriorate, and regular inspection and renewal of such is advisable. Leaky valves are often a trouble; in this connection, first-class products should always be used rather than cheap valves. Cheap valves will rapidly cost more in leakage than the saving in initial cost.

Air Screening

The provision and maintenance of efficient air-screening equipment is one of the best means of protecting an air system and improving the economy and safety of its operation. To the dangers of dust deposits must be added the abrasion of cylinders, contamination of lubricating oil and interference with oil-spread. Air filters usually consist of some arrangement whereby the air is made to impinge upon oil-coated surfaces, thus removing the dust impurities. Some filters automatically clean themselves, others can be cleaned in sections as they become choked up. In choosing such a filter, the points to investigate are the resistance set up to the passage of air; the efficiency of dust removal (this is usually indicated by the number of times the air changes its direction of flow, impingement being usually achieved at each change of direction); the frequency with which cleaning is required, and the ease with which cleaning can be carried out.

The extent to which contamination and maintenance work can be saved by a good filter is shown by considering the amount of abrasive matter which can enter the air system. In ordinary clean conditions, each 1,000 cub. ft. of air may contain something of the order of 3 or 4 grains of dust. At this capacity per minute, a compressor would therefore draw in about ½ lb. of dust during 10 hours' operation. Continuous operation would involve a corresponding increase, and while all the dust may not stay in the compressor it is evident that there is ample scope for formation of deposits, lodging on cylinder walls and preventing spread of lubricant in places, etc.

Opportunities for economy are sometimes revealed when a survey of works' air requirements is made. The writer recalls as an example of this situation a works having three compound compressors delivering air at about 100 lbs. pressure. The expansion of the works for some time had made it seem imperative that an additional compressor should be installed. Before proceeding with this, a review of air requirements was made. It was then revealed that owing to elimi-

(*Concluded on page* 192.)

Notes on Steel Foundry Practice*

By S. LEETCH

When asked to describe in the form of an hour's lecture what is happening daily in the steel foundry, the author found it necessary to give careful consideration to the way in which he should deal with it, for it will readily be realised that when dealing with a castings production of over 200 tons weekly, where three types of melting plants are used and where 40 per cent. of the total output is other than plain carbon steels, it is essential to have a clear-cut line of procedure. Therefore, it was decided that the sands used should be the basis, *i.e.*, oil sand, green, dry and compo, and the various points of interest shown on jobs made in each of the above materials will be given.

FIG. 1.—CASTING BAY WITH MOULDS READY FOR CASTING.

It is not intended to deal with the three steel-making processes employed—the Tropenas converter (acid), Hèroult electric (basic) and high frequency (acid)—nor with the operations subsequent to moulding and casting, but, in passing, it is of interest to record that the works concerned were the first steelmakers in this country to operate each of the three types of melting plants, the Tropenas in 1891, the Hèroult in 1910 and the high frequency in 1929. There is also a small Rennerfelt electric furnace, of 15 cwts. capacity, which is chiefly used for melting alloys, used in conjunction with the Tropenas plant.

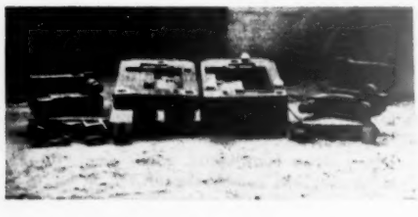


FIG. 4.—DRIED MOULDS READY FOR ASSEMBLY.

Oil Sand Practice

As oil sand will be referred to at different stages, this subject will first have consideration. Fig. 1 shows one of the casting bays, with moulds assembled ready for casting, and before proceeding to describe the production methods for a typical job in oil sand moulds, there are a few points of interest to discuss, such as the absence of moulding boxes. The steel is shown being poured from a 30-cwt. capacity ladle, and it is a tribute to the strength of the oil sand mould that, except for very small light work, a comparatively large ladle can be used. This fact, coupled with that of the mould breaking down at an early stage and thus permitting free contraction, is a very valuable asset. The white lines on mould in foreground show the amount of reclaimed sand used. Owing chiefly to the high cost of bonding materials, oil sand mixes are expensive, and were it not possible to use a high percentage of reclaimed sand, the cost would be such as to prohibit their use save for exceptional jobs. The methods of reclamation will be discussed later. Incidentally, however, by shaping the frames to suit pattern sizes, a saving in sand results. Fig. 2 shows a signal gear box carrying a very light section. For instance, the main walls are only ¼ in. and smooth mould faces essential to ensure running. The mould is cast quickly with a good stream of steel, obtaining adequate pressure.

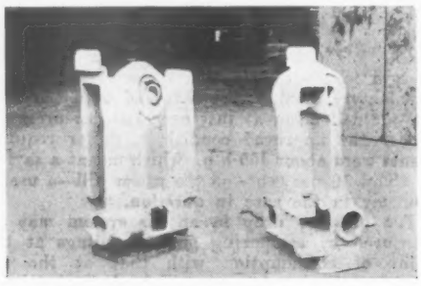


FIG. 2.—SIGNAL GEAR BOX CASTINGS.

Fig. 3 shows the pattern and core box equipment. The former is dowelled into a frame, which has tapered sides to minimise rapping. The joint face is plated to prevent wear; this is an important factor as it has a profound effect on size of the finished casting. The heads and runners are fixed on to the pattern—a method which carries many advantages. Facing sand is tucked round the pattern to a depth of 1 in., and then the frame is filled with reclaimed sand; it is flat rammed and the surplus sand is strickled off. The importance of using a straight strickle cannot be over-emphasised and a flat mild-steel plate is placed on the strickled face. The whole job is turned over on a trestle, the frame is drawn off, and the pattern is withdrawn from the mould. The mould resting on a flat plate is removed to the drying stove. This plate must be perfectly flat, as it contacts with the joint face of the mould and any variation is carried thereto. Thus for ensuring rigid control, a weekly check for flatness is carried out on these plates. This method of moulding has but little deleterious effect upon the pattern equipment and very few repairs are necessary, yet it is essential that the pattern and core boxes be regularly painted and varnished.

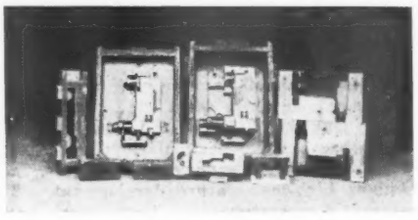


FIG. 3.—PATTERN AND CORE BOX EQUIPMENT FOR SIGNAL GEAR BOX CASTING.

FIG. 5.—MOULD WITH CORES IN POSITION.

Fig. 4 illustrates the dried moulds and cores, ready for assembling. Buttons are used for ensuring correct setting.

Fig. 5 shows the mould with the cores in position ready for the turning over of the top, and also the mould completely assembled, ready for casting. The method of fastening together the mould parts is by means of strong steel clamps and wooden wedges, the latter having distinct advantage over metal for this purpose. The additional length of heads is noteworthy, as is also the runner bush, which is gummed in position whilst the mould is still hot, there being no need for further fastening-down precautions.

The moulds ready for casting are shown in Fig. 6. They are removed from the shop by means of a roller conveyor to the knocking-out shed, where a proper system of fume exhaustion is provided. Fig. 7 shows a sectioned casting and a casting with heads and runners on.

Sample Castings

The procedure for dealing with a sample casting, when large quantities are required, is to mark out, machine below size, then saw into various sections to ascertain whether sound or not. It is inadvisable to proceed with bulk manufacture until the management is satisfied on these points. One of the chief characteristics of this method of production is uniformity in every respect, and with sand, steel, heads and runner of fixed sizes and shapes, drying-stove temperature controlled, once a satisfactory sample has been obtained, it is only a matter of routine supervision and checking to ensure the bulk attains the standard set. Of course, this method of production is only practised when it is felt that a first-class job cannot be obtained by using cheaper, or alleged cheaper, methods, and it has been found to be admirable for castings on which a great deal of machining has to be carried out, such as Vee-rings, spiders, stainless valve castings, seats, manganese-steel castings to be used as renewable parts, digger teeth, liner plates, split bushes, and the like. The client who has to fit the parts on site lays great stress on this point, and it is a good selling point. Additionally, there are the light intricate castings, such as the one described. Even so, there is sufficient to keep 50 men and youths continuously engaged, and when, a few years ago, work was very slack, no difficulty was ex-

FIG. 6.—MOULDS READY FOR CASTING.

* Paper read before the Sheffield Branch of the Institute of British Foundrymen.

perienced in keeping this section of the works fully employed.

Sand Used

When this method of production was put into commission in 1926, experience was available of making small oil-sand internal cores, using dry silica sand with 5 per cent. of a proprietary oil, milled for 4 minutes, and this mix was used. As the process developed and heavier classes of castings were made, sagging of the mould took place, so, whilst retaining the mix for light work Belgian red sand and Bawtry sand were added in the proportion of 4 parts of silica, 1 of Belgian, 1½ of Bawtry with 5 per cent. of the oil. Since then the practice has reverted back to all silica sand, replacing the Belgian and Bawtry with ½ per cent. Bentonite. Also, as the result of some patient research work by the author's colleague, Mr. A.

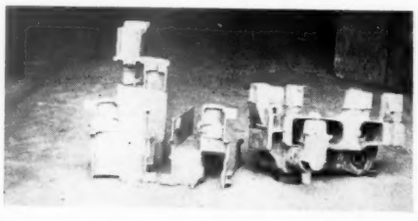


FIG. 7.—SAWN CASTINGS AND ONE RETAINING RUNNERS.

Wheeler, of the research laboratory, it was found possible to put down plant and make a suitable core compound—an emulsion of dextrine, linseed oil and water. Even with this saving, the management is still faced with the necessity of drying the silica sand, and therefore for some considerable time it has been devoting a good deal of attention to a cereal binder, used in powder form, with linseed oil, which dispenses with drying of the silica sand up to 6 per cent. moisture content, and whilst it is too early to say definitely that it will be possible to use this mixture throughout, the results obtained so far are most encouraging.

Reclaimed Sand

The burnt portions of the sand are separated and the remainder fed into a jaw crusher

FIG. 10.—BODY CORE.

machine; an inclined conveyor belt carries the sand over a magnetic separator, which rejects lifters, pieces of steel flash, etc. (obviously care is taken to ensure no manganese steel scrap is passed through the crusher), and 10 per cent. new silica sand is added whilst the crushed sand is passing up the conveyor belt. It is then passed through a K.B. pulveriser, and from there it is elevated by a bucket conveyor, passed through a de-silting chamber, then along a horizontal belt conveyor into a storage hopper, immediately above a Rotoil mixer. A measured quantity of sand is fed into the mixer, 2½ per cent. oil binder added plus 1½ per cent. water. It is then milled for 2½ minutes.

The mixture is strong enough for backing purposes and as it breaks down under heat quicker than new sand mix, is admirably suited for this class of work. It can be used as a facing sand on light work, but even then, a silica paint is essential in order to obtain a good face. Two men are necessary to operate this plant, one feeding the sand into the crusher, and the other controlling the mixer. It has been found advisable to clear away the whole of the backing sand every four weeks, owing to constant use causing deterioration.

Green Sand Practice: Dredger Bucket

Fig. 8 shows three dredger bucket body castings on to which are riveted renewable manganese steel lips. The main wall thickness of the body is ⅝ in., which is light compared with the sections of the bucket eye and lugs. This sharp change in section calls for special precautions

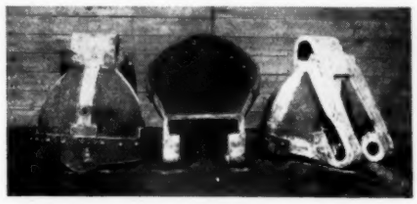


FIG. 8.—DREDGER BUCKET BODY CASTINGS.

against pulling, and the following production methods have proved to be satisfactory.

The main body core box, illustrated in Fig. 9, shows the closing pins in position. The box is of sturdy construction and is made for the outer frame to be drawn off vertically, leaving the loose pieces surrounding the core to be afterwards drawn away horizontally, thereby avoiding rapping and distortion. The slightly-raised corner-plates ensure a sand to sand joint. This core box is placed mouth uppermost on a steel moulding plate; it is partly rammed up and the chills are placed in position. The moulding box part is then placed in position, the closing pins being used for location purposes, and the ramming is continued, lifters being hung from the box bars. As this part becomes the bottom part of the complete mould, a plate is clamped on and the whole turned over.

FIG. 11.—PATTERN AND CHILLS USED FOR DREDGER BUCKET BODIES.

The body core (Fig. 10) is made of green sand, and it will be readily appreciated that, by making the moulding tackle in this manner, the bottom part of the mould and the main body core are made in one operation, thereby reducing cost of production and simplifying the closing operation. The two white marks show chills set in the two sharp corners. The runner—formed of runner bricks—is of the fountain or bracket type. It is set immediately under the cross bracket, which can be seen in the illustration and it is put there to prevent pulling. One of the weaknesses of green sand practice is the burning on of the sand adjacent to the runner, and the core is always pipe-nailed over an area of the face immediately above the runner. Firebrick runner bricks are used for the down-runner.

The pattern and chills used are shown in Fig. 11. Six chills are used per mould, which is rammed up on a pneumatic moulding machine. The closing operation (Fig. 12) shows the top part being lowered into position, the round and slot lugs and closing pins being seen. With such thin wall-sections, it is imperative there should be no play in the pin holes, etc., and one man is detailed off, as part of his duty, to check wear on pins, holes, etc., damage to moulding

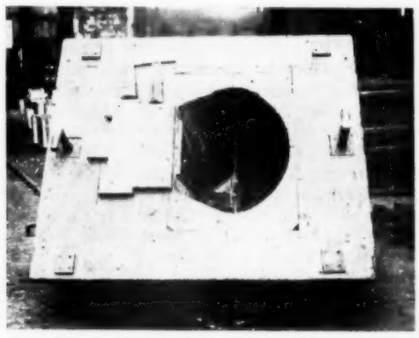


FIG. 9.—MAIN BODY CORE BOX.

boxes, etc., and see all these details are kept in first-class condition. The importance of this seemingly minor part cannot be stressed too strongly, and the results of making one man responsible, more than justify the cost. The runner bush is made of baked oil sand painted with a silica paint and is 8 in. square by 5 in. deep, with a hole of similar size to the down runner in the centre of the bottom face. To prevent splash, scum, etc., getting into the mould proper, a 3 in. sq. aluminium plate, ⅛ in. thick, is sprigged over the hole immediately above the down runner. By the time this plate has melted there is a good head of steel in the

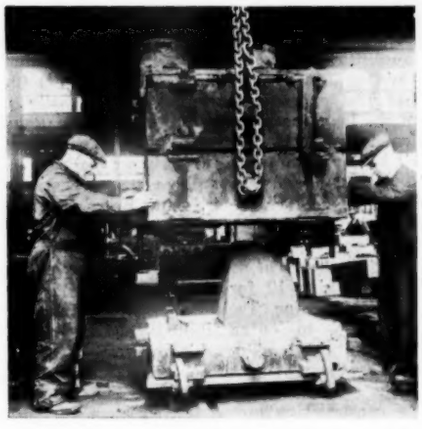


FIG. 12.—CLOSING OPERATION.

bush, and the pourer endeavours to keep this up until pouring is completed. It is felt that on all classes of work, run from the bottom, it is important that sufficient steel is provided in the ladle to ensure the runner bush is not drained. One head 6½ in. dia. by 14 in. long is placed on the top of the main eye.

(To be continued.)

THE MEMBERS and Council of the Birmingham, Coventry and West Midlands Branch of the I.B.F. thank all donors for contributing to the entertainment fund opened on the occasion of the visit of the International Delegates to Birmingham in June.

Foundry Education and Training in Great Britain*

By J. G. PEARCE,† M.Sc., M.I.Mech.E., M.I.E.E., F.Inst.P.

Much has been written from time to time on this subject, and it is intended that the present Paper shall be in the main a record of facts. In particular, it gives an account of the aim and work of the British Foundry School, which opened in 1935.

Until recent years, foundries were conducted mainly on a basis of skilled craftsmen, led by foremen and managers who had in many cases had long practical experience in the patternshop or on the foundry floor and who had proved their capacity to hold posts of higher responsibility. This system gave this country an enviable reputation for craftsmanship. To-day, two developments have changed the whole aspect of many sections of the industry, and seem likely to change it still more. The first is the application of those methods of continuous and mass production which have already so profoundly influenced the remainder of the engineering industry; the second is the establishment of a vast body of technical and metallurgical knowledge relating to the materials, processes and products of the industry. These developments have brought about great changes in outlook on the problems of education and training and, indeed, are responsible for raising them seriously for the first time, since the ordinary system of apprenticeship and promotion sufficed to meet the needs of an industry working on a jobbing basis.

The main source of supply of operatives is inevitably the primary school, and the normal school-leaving age of 14 has recently (Education Act, 1936) been raised to 15, except in cases where the parents wish the boy to enter employment and the education authority is satisfied that this employment is "beneficial." There is a strong body of opinion in favour of no exemptions at all, that is, a universal leaving age of 15, and some associations of employers and employed have already intimated that it is preferable to recruit employees at 15. Sound apprenticeship schemes enrol young people for trade apprenticeship up to 16, since it is found that the extra educational period easily outweighs in value any loss from a shorter apprentice period. At the same time, the closing of blind-alley occupations to young people under 15 as non-beneficial employments (*i.e.*, offering no training of value or future prospects) should react favourably on firms who could take more young people than they normally can obtain.

Certain types of senior or central schools take boys at 11 or 12 for a three-year or four-year period. Junior Technical Schools take boys, who wish to enter industry, from primary schools at 13, and provide a two-year or three-year course, with a pronounced vocational bias in the case of those preparing boys for entry to the constructive industries, in such subjects as workshop practice, machine drawing, etc. Such schools form a very desirable source of trade apprentices, but there is no information as to how many from this source enter the industry. The secondary and grammar schools also receive young people from primary schools (public or private) at about 11 or 12, and take them approximately to the standard required for university entrance. Comparatively few boys from these schools enter the industry, except for employment in laboratories and offices.

The Hadow report (1931)[1] is accepted generally as indicating the future lines of development of post-primary education in this country, and, broadly speaking, these aim at a primary school training to the age of 11 and then transfer, according to ability, desires of pupil and parents, etc., to another type of school, senior, secondary, etc. The raising of the leaving age was a logical consequence. The Spens report recently issued (1939)[2] marks a further development of the Hadow scheme, and envisages the growth of types of school which, without sacrificing the demand for a good general education, will recognise that activity and experience are important channels to knowledge and will prepare boys more directly for industrial employment, and thus meet the criticism that ordinary secondary schools prepare boys for the so-called black-coated posts. Thus it envisages the development of technical high schools, ranking with the secondary schools, but directing pupils to industry as the present type of secondary school tends to do to commerce.

The school-leaving certificate forms a suitable criterion of standard reached by secondary-school boys, and until recently this has been accepted, subject to certain conditions, as a substitute for matriculation or university entrance examination, although this tended to such undesirable modification or specialisation of curricula that the plan has recently been abandoned. A university entrance examination in a limited number of subjects is not a desirable form of certificate for boys who are not in the main preparing for the university. Nevertheless, a suitable leaving certificate is very useful to employers as an index to standard reached, and invaluable to its owner as a basis for acquiring a professional certificate by part-time study. Some boys stay long enough at the secondary or grammar school to take the higher school certificate, which roughly covers the first year of a university degree course, *i.e.*, to the intermediate degree examination, at any rate in scientific subjects, mathematics, physics, chemistry. Young men leaving school for industry with the intention of securing a professional qualification or external degree would do well to get the higher school certificate from school. Such qualifications are those of the Institution of Mechanical Engineers, Institution of Electrical Engineers, Institute of Chemistry, Institute of Physics.

The number of universities in Great Britain having departments of metallurgy, or offering instruction in metallurgy, is about ten, but the number of students actually taking degrees in metallurgy is small[3]; so much so, that no great recruitment of university graduates to the industry is to be expected, although further reference is made below to institutions offering full-time foundry training. For university men who are without industrial experience, the author firmly believes in the advantages of a short works apprenticeship, in which experience is gained of various departments and in which both the apprentice and the employer have opportunities of finding out whether staff employment is suitable. Part of this is most advantageously taken between leaving school and entering the university.

One can thus picture the bulk of those who go into the industry doing so with a primary education, a very small proportion with a secondary or higher education, and a still smaller proportion with a university qualification. Continued education takes place after entry to industry through part-time evening study in local technical colleges, although some colleges also offer facilities for part-time training during the day for one or two days a week. Little provision of this kind is made for or used by the foundry industry. Part-time continued education is treated further below. It is understood that part-time evening continuation education, which, of course, is entirely voluntary, attracts about 5 per cent. of those eligible to attend (*i.e.*, those between 14 and 18 not pursuing a full-time educational course), while a further 5 per cent. of those in industry already taking part-time education attend part-time day, as distinct from evening courses. These figures refer to industry as a whole. Employers can greatly assist attendance by encouraging apprentices to attend, paying fees, and so on.

Apprenticeship

In days when industry was mainly a "mystery," and an affair of practical experience and individual craftsmanship, developed from a long period of training, indentured apprenticeship was the method of training. After serving a master, the apprentice gained further knowledge and experience by working elsewhere, as a journeyman. The changes in industry have, except in a comparatively small number of cases, resulted in a decline in apprenticeship, and young people entering the industry obtain their experience of the industry on whatever work is going through the shops, without entering into an obligation binding on either employer or apprentice. A distinction, however, does still persist between the young man who works on an apprentice basis and the handy youth who works to satisfy his immediate need for employment rather than to learn the trade. Learning from experience, however, cannot strictly be regarded as training, which involves two things.

Whatever the limitations of a shop in size or scope of work, young people being trained should have opportunities of working on all the types of work in the shop, with, if possible, periods in patternmaking as well as moulding and coremaking, as well as a brief spell in a machine shop. The drawing office and laboratory could be included in exceptional cases. Secondly, young people should be taught the operations instead of being allowed merely to pick them up by watching older men. Such training is not only valuable in conferring manual skill. The experience of shop discipline, shop organisation, of co-operation to a common end, are also very valuable parts of the training, and, more than anything else, a spell in the shops shows a young man whether he finds the industry congenial and his employers whether he has the qualities needed for practical foundry operations. It will be obvious that such training can only be obtained in an industrial establishment, and that no school or college can usefully offer or claim to offer practical training in lieu of this.

At the same time, provided this is understood, the limited provision offered by technical colleges serves a useful purpose, in facilitating experiments impracticable in a works, and in providing instruction in elementals to those engaged in engineering and other metallurgical operations and not in the foundry trade itself. The same applies in lesser degree to the small training shop for apprentices in larger works, such as are often found on the Continent. It has the advantage of offering work carefully graduated in difficulty to the boy in his early stages, but the period there should not be unduly prolonged.

In one large British works, a scheme is found which admirably combines the need to-day for combined practical experience and technical knowledge. Six months' probation is served after education, preferably at a junior technical or central school, and a physical examination is passed. Skilled apprentice instructors supervise the practical training, which is tested every six months, and instruction in subjects of general and technical education is provided in the works' school. Facilities exist whereby every ambitious young man may rise to a post of superior responsibility. In training university men for engineering posts, the same company arranges for the three months of the first year to be spent in the foundry or patternshop.

* Paper presented to the International Foundry Congress in London, organised by the Institute of British Foundrymen.
† Director, British Cast Iron Research Association.

Such a scheme well illustrates not only the requirement to-day of a combination of manual skill and technical knowledge, but also of an adaptability of mind to meet the changes industry will produce. As a whole, it must be regretfully admitted that only a small proportion of those entering the industry are practically and technically trained for whatever grade they hope to occupy within it.

The main objection to an apprenticeship confining the young man to one foundry is that, even in a good general foundry, the variety of work is limited. One interesting proposal to overcome this difficulty, due to Ingall,[4] provided that apprentices undergoing a full-time two-year course of training in the area served by the Constantine Technical College, Middlesbrough, should regularly visit and work in the whole of the shops sending apprentices to the group. It is unfortunate that this scheme of full-time training is at present suspended, although it may be revived on a sandwich basis of six months in the College and six months in the works.

It is now proposed to consider the facilities offered to and qualifications open to the operative, the technical and the executive grades for technical training, bearing in mind that experience in a foundry is not necessarily foundry training and that foundry education is only one factor in success in foundry executive work.

Technical Training for the Operative or Craftsman

In providing facilities for young people to acquire some knowledge of the technical basis underlying the industry, the technical schools have to face two conditions which materially affect the nature of these. The first condition is that attendance is on a voluntary basis, and it is only in recent years that technical schools have been able to induce students to take a course in closely allied or grouped subjects, as distinguished from isolated subjects. The consequence of this is that attendance is undertaken only by those more able and far-sighted young people who desire to make use of the education in securing positions of higher responsibility. This is a perfectly natural and desirable procedure, and gives valuable help to those who would previously have risen purely by virtue of qualities of character, personality and perseverance, but who would to-day find themselves unduly handicapped by lack of technical knowledge. Were the education system faced with providing instruction for all young people in industry, that is, on a compulsory basis, the method of approach would necessarily be entirely different.

The second condition is that the schools cannot confine instruction in foundry subjects to purely foundry students, with the result that in foundry classes there is always, apart from moulders and patternmakers, a proportion of students from other branches of engineering and others who for various reasons desire to learn something of foundry science. This materially affects the attitude of the technical colleges to practical work, for students outside the industry have no opportunity of gaining any insight into practical founding except through such provision as is made by the technical colleges, although the foundry apprentice can only learn his trade in the foundry itself. There is also difficulty in obtaining suitable teachers of foundry subjects. The skilled practical man does not always possess the necessary gift for imparting his knowledge and the trained teacher has seldom had training either in foundry science or practice. This deficiency is now, however, being made good.

In formulating courses for the technical training of young foundrymen, it is generally considered that, for evening study, two years' part-time work is required in calculations, science and drawing, in order to establish the necessary foundations beyond the work of the primary school, and a further three years' work to enable the apprentice to reach a qualifying standard. Secondary and junior technical school boys may, of course, short-circuit the preliminary course. The qualifying standard is admirably provided by the examinations of the City and Guilds of London Institute, which conducts each year two examinations in patternmaking, intermediate and advanced, and one examination in foundry science and practice, which at a later date may be similarly divided into two grades. The examinations are controlled through an Advisory Committee, largely nominated by this Institute. The examinations are wholly written and without the wholehearted co-operation of the industry it would not be possible to arrange practical examinations at a large number of centres, but for the reasons indicated above, the written examination meets the requirements of the present voluntary basis very satisfactorily. The syllabuses for these City and Guilds examinations are available to those interested on application to the Institute.

So much criticism is directed at examinations and examining bodies that it is satisfactory to report the favourable influence of these particular examinations on the growth of foundry instruction, for there is little doubt that the existence of the City and Guilds syllabus has facilitated the provision of classes by the technical colleges. In 1930 Ingall reported that 27 technical colleges providing classes in foundry technology had barely 200 students. In a recent inquiry, the author had replies from about 40 technical colleges, providing classes in patternmaking and/or foundry work, about 30 of which specifically provide courses leading to the City and Guilds examinations, while several others are making provision for this in the near future. In several other cases students are prepared for the examinations of various regional bodies, such as the Union of Lancashire and Cheshire Institutes, or the East Midlands Educational Union.

While no specific inquiry was made about numbers, the information received suggested that in eight of these institutions the number of students totalled nearly double that recorded by Ingall, although there was very general admission of the difficulty of securing the presence and regular attendance of foundry students. At the same time, from the scanty data available, it is thought that the foundry industry is at least up to the average of other industries in the proportion of young men undertaking voluntary part-time education. The provision of syllabuses for these examinations and the preparation of examination papers by those closely in touch with the industry have undoubtedly had a favourable influence, and the technical colleges are to be congratulated on their efforts to establish classes.

Technical Training for Intermediate Grades

The development of the industry has resulted in a very much more diversified group of occupations and a greater demand for men needing some technical knowledge than was the case a few years ago, such posts including chemists, laboratory assistants, inspectors, testers, estimators, rate fixers, progress men, and so on. Those who have such posts, or the more ambitious workmen who hope to get them, are provided for by the endorsement in foundry science of the National Certificate in Mechanical Engineering, ordinary or higher, of the Institution of Mechanical Engineers.

The national certificate, resulting from a co-ordinated and progressive course of study in a particular group of subjects, is the natural result of the development of the course system in technical schools, and usually a certificate can be obtained after three years' study for the ordinary certificate and about five years for the higher certificate, which is regarded as reaching university degree standard in its particular subjects. About eight of these certificates are now available in various branches, mechanical, electrical and gas engineering, chemistry, etc. Since no such certificate exists in metallurgy and since the production of castings is as much an engineering as a metallurgical task, arrangements were made by the Institute for the endorsement in foundry science and practice of ordinary and higher national certificates, issued under the ægis of the Institution of Mechanical Engineers. This can be done by the student taking a course subsequent to obtaining the certificate or during the certificate course.

In accordance with the usual practice governing national certificate examinations, the syllabuses and examination papers are arranged by the technical college and externally assessed, while the scripts are marked by the college and assessed externally. The college is therefore much freer than those teaching to an external syllabus, and local industrial requirements can be kept in mind. While the present position with regard to qualification for the intermediate technical grades cannot be regarded as entirely satisfactory, the arrangement does offer something until a better basis can be established. Information received suggests that eight technical colleges offer or are prepared to offer courses leading to the foundry endorsement of the Higher or Ordinary National Certificate, and one college offers a Foundry Engineering Course leading to the Ordinary Certificate in subjects best calculated to assist the foundry engineer. For those who are in a position to begin the course with the aim of foundry endorsement in view, such a foundry engineering course is to be warmly commended.

(To be continued.)

Match-Plate Duplication by Metal Spraying

Mr. M. E. Lawrence, chief engineer, Turner Brass Works, of Sycamore, Ill., writing in "Metal Industry" (New York) on the subject of metal spraying, points out that the pattern-shop presents many uses for this process. The making of duplicate patterns, temporary match plates, temporary core boxes and repairs on worn metal patterns are cited as typical applications. It is often necessary to make extra patterns for short runs because casting from a single pattern is costly, yet permanent match-plates are too expensive. By the use of metal spraying, temporary match-plates are easily and quickly made. A shell of metal is sprayed over the master pattern of wood, plaster, soap or wax, and this shell is backed up with plaster for strength. The metal surface is then covered with a thin film of oil and is used as a female. A shell about $\frac{1}{32}$ in. thick is then sprayed into the female shell and backed up with plaster. Inserts are set in the plaster and the surface levelled. These inserts are used to anchor the pattern to the match-plate. As many patterns can be put on the plate as desired.

Emergency Addresses

The following changes of address have been announced in addition to those given in the JOURNAL last week.

THOMAS E. GRAY & COMPANY, LIMITED, to Isebrook Works, Polewell Lane, Barton Seagrave, near Kettering. (Tel.: Burton Latimer 240.)

THE INSTITUTE OF WELDING (for matters referring to membership, publications, accounts and general inquiries—Mr. A. Kershaw), to 21, Smithamdowns Road, Purley, Surrey, and (for research, civil defence) to 404, Frobisher House, Dolphin Square, London, S.W.1.

INSTITUTION OF MECHANICAL ENGINEERS, to The Meadows, Betchworth, Surrey (telephone: Betchworth 63). The Institution building in Storey's Gate will remain open for dealing with personal inquiries and for members wishing to make use of the library.

ROYAL SOCIETY OF ARTS, to Buxted Park, Sussex.

PENTON PUBLISHING COMPANY, LIMITED (Mr. V. Delport), to 7, Kenton Gardens, Kenton, Harrow, Middlesex.

VULCAN FOUNDRY, LIMITED, to West Woodhay House, Newbury, Berks.

D

Investigation and Modern Ideas on Enamel Control

When Mr. G. H. Abbott presented his Paper on "Investigation and Modern Ideas on Enamel Control"* to the Northern Section of the Institute of Vitreous Enamellers, it gave rise to the best discussion of the Session, and an abstract is printed below.

The Joint Committee

MR. W. H. WHITTLE, referring to the Chairman's (Mr. H. Whitaker) opening remark that Mr. Abbott seemed to have searched all the literature dealing with the subject, said he would like to mention that the Institute, with the collaboration of the British Cast Iron Research Association, had practically completed a world bibliography of the literature dealing with vitreous enamel. If Mr. Abbott had had such a bibliography when he started on his research work, it would have been of very great assistance to him. Mr. Abbott had made reference to a complaint as far back as 1901 that in this country we were behind to some considerable extent. In the hollow-ware trade that had been the case pretty well up to date, although it might have recovered a little now. That was due mainly to the fact that we were a very conservative nation. It was to remedy that state of affairs and to try to get enamellers to work together and pool their ideas that the Institute was formed. They were now on the right lines with general research work. It was gratifying to know that the Joint Technical Committee with the B.C.I.R.A. was doing such useful work, and had appointed Mr. Abbott as one of the committee. It would, however, be appreciated that research work was a slow job, so he would ask them to be a little indulgent and not expect too much quickly.

MR. ABBOTT, in reply, thanked the Chairman and Mr. Whittle for what they had said. Regarding published work on vitreous enamelling, he had found the enamel bibliography of the American Ceramic Society extremely useful, and it would be a great help to have it brought up to date. He thought it was important to know the present position of the export enamel trade, and it would be useful if someone in the Institute could give them some figures.

A New Bending Test

MR. W. MAVOR asked whether Mr. Abbott had found the bending machine which he had described better than the other type which had three rollers, the centre one being brought up constantly.

MR. ABBOTT replied that he had read about the Danielson-Lindemann cross-bending machine, but had never used it. The simple power-driven machine which he had described was designed to improve upon flexing by hand, and permitted observations on both side of the test-piece. At the time it was built he had not read of the other machine.

Adherence and the Oxide Film

The CHAIRMAN asked whether it was not a fact that there was a very thin film of oxide between the metal and the ground coat, and that the physical properties of that were equally important. Had that been investigated to any extent? Did not the lecturer agree that the properties of that film were of very great importance in determining the adherence of the enamel to the metal? By that he meant the adherence of the oxide film to the metal.

MR. ABBOTT replied that he had not had time to say much about the oxide film, but Dr. White in his Paper had dealt fully with the part played by oxygen in the enamelling of iron and had described some original experiments on the rate of oxygen diffusion through an enamel layer. He thought it was a mistake to think of enamelled iron as metal, plus oxide film, plus ground-coat plus cover-coat. Certainly a film of oxide was formed on the metal as soon as the ground-coat was put in the furnace. This could be observed by rubbing off the biscuit about a quarter of a minute later. But when the ground-coat melted this oxide film was dissolved in it. Besides in a cobalt ground-coat there were other changes taking place adjacent to the metal. German workers had shown experimentally that metallic cobalt was formed by reduction, and in the neighbourhood of the sheet iron it set up galvanic cells and corroded the sheet. In a well-fired ground-coat there was actually little oxide present at the boundary of the enamel and metal, and experiment showed that enamel adhesion was not simply adhesion of oxide to metal.

The Annual Conference of the INSTITUTE OF VITREOUS ENAMELLERS, which was to have been held in Birmingham from September 22 to 24 under the Presidency of Professor J. H. Andrew, D.Sc., has been cancelled.

The CHAIRMAN asked if Mr. Abbott would not say that the solution of the oxide in the ground-coat was an appreciable factor in altering the physical characteristics.

Defects in Screen Testing

MR. ABBOTT replied that the solution of iron oxide in the ground-coat certainly altered its physical characteristics. For example, for ground-coat frits which had cubical expansion coefficients between 245 and 289 $\times 10^{-7}$ the expansion of the enamel layer adjacent to the iron was 380 to 390 $\times 10^{-7}$.

In reply to the question about milling tests, Mr. Abbott said that the screen test was not used at all at National Enamels, Limited. The elutriation test was quicker, and gave a satisfactory result. Moreover, they had found when trying the screen test that the enamel residue sintered on drying and tended to fall through the sieve.

A MEMBER said that in a Paper read to the Society of Glass Technology a few weeks previously it had been stated that the results of a screen test were not reproducible with different operators. It was found there was a personal element in the test.

MR. ABBOTT replied he had not heard that before. It was interesting to note, however, that the usual fineness test was based on the amount of a single fraction of coarse residue. No account was taken of the fineness distribution less than 150 mesh. The point had been studied by the Standards Committee of the American Ceramic Society, who were satisfied that the coarse residue was an index of the fineness of the batch as a whole, but the work of E. P. Poste threw some doubt on the matter. The single effect elutriator was based on the same assumption, but the apparatus could very easily be extended to obtain any number of difference fractions.

Differential Expansion Curves

MR. A. BIDDULPH said that regarding Mr. Abbott's remarks about the enamel residue from the screen test sintering during drying, he wondered whether it was due to drying at too high a temperature. It was his experience that the residue would not sinter if dried in a steam oven, but he had seen screens dried off on the hot bars of the fusing fork. He was glad to hear wnat had been said about the old enamels. Recently he had seen a comprehensive exhibition of old enamels at Bilston, which included a demonstration of the various stages of the process.

Mr. Abbott had referred to Dr. White's experiments on adhesion. One of Dr. White's colleagues, Dr. Caufield, was studying viscosity with a rotation type of instrument, slightly different from the one which had been illustrated. He mentioned that to show that some research was being done on this side of the Atlantic.

The differential expansion curves for enamel and iron had shown a kink at a moderate temperature. Some years ago he was doing experiments on those lines, but not with the same degree of accuracy, yet he did find in plotting the results a distinct kink in the expansion curves between about 620 and 750 deg. C. He was speaking from memory, but it was in the range where the enamels were just about softening. The results were taken on a falling temperature, not on a rising one.

He was particularly impressed by the absence of blisters and bubbles in the white enamel, as shown by the author's illustrations. It had been his experience that the ground coat was usually far more free from bubbles than the white, due probably to the opacifier suspended in the white which in polishing came up in tiny little holes. He wondered if there was anything special about the white enamel which was shown on these photomicrographs.

Elutriation Tests

MR. ABBOTT replied that his experience with sintering was that it could take place in a residue dried in a steam oven at 100 deg. C. In fact one test submitted to them by a supplier recommended that after the residue had been dried and before measuring its volume, the sieve should be thoroughly shaken to get rid of fines! Of course, if dried rapidly on hot bars, the risk of sintering would be much greater.

He was very interested to hear about the exhibition of Bilston enamels, and the work proceeding on the viscosity of molten enamels with a rotating cylinder viscometer. He had had a

* See FOUNDRY TRADE JOURNAL, June 8, July 6, and August 3, 1939.

Paper passed on to him describing viscosity determinations on molten slag systems at the Royal Technical College of Glasgow, in which a similar viscometer was described.

He was rather surprised at the temperatures mentioned by Mr. Biddulph in connection with his expansion measurements. His enamels must have been more refractory than most. The sudden change of expansion at certain temperatures was characteristic of all glasses, and was thought to be due to a molecular re-arrangement.

In connection with his remarks on elutriation he should have mentioned, especially in Manchester, that the Proceedings of the Manchester Philosophical Society recorded a number of experiments about the year 1900. In a study of the solubility of lead frits, fineness distribution was determined by elutriation. The work was followed up with an investigation by the Government chemist at that time, who observed a strange result. The fractions of frit obtained by elutriation had different specific gravities—evidence that the frit consisted of a mixture of compounds. This might have a decided effect on the properties of an enamel.

Transposing Frit Analysis

MR. A. K. WILLIAMS asked if the frit analysis which had been given was one from an American Paper which the author had tried to transpose. He thought he would agree that it was difficult to reproduce the same frit from an analysis. The conditions of melting had to be taken into account, and there would be many changes taking place which, without the original composition, they would be unable to determine. At one time one of his raw materials was borate of lime, which gave excellent results, but unfortunately the supply was cut off. They had tried to reproduce the same enamel from different raw materials, but the result was not the same. The enamel was a good one but it was different.

With regard to the kink in the curve which Mr. Biddulph had mentioned, it was known that with steels the more impurities there were the more changes took place affecting expansion and contraction curves. He thought that more or less corroborated the supposition that the same thing was taking place in the glasses.

MR. ABBOTT replied that he felt Mr. Williams has understood the expansion table which was shown. It gave the comparison of the calculated and determined values for the coefficient of expansion of the frit of which the analysis was given. The actual chemical analysis was not given in an American Paper, but was made here. No attempt had been made to reconstruct the formula of the enamel mixture, but the chemically determined fluorine was transposed into calcium and sodium fluorides so that the Mayer and Havas' factors could be used. The expansion coefficient obtained in this way was then compared with that determined experimentally.

The reconstruction of enamel formulæ from chemical analyses was quite a different matter. He agreed that allowance had to be made for the materials lost during smelting, and the outstanding work of E. P. Poste was a guide in this respect. Poste had withdrawn samples of frit at different stages during smelting, and by analysis had shown that boric oxide, sodium oxide and potassium oxide were progressively lost. It was recognised, though perhaps disputed by borax suppliers, that considerable amounts of boric oxide could be lost, which had to be taken into account when trying to reconstruct an enamel formula from a chemical analysis.

He would like to retell a story which was told by the chemist of a large company here. The company had employed a recognised enameller to make their enamels, and by the agreement the formulæ were deposited in a sealed envelope in the safe of the company. By analysis of the frit the formulæ were reproduced so well that the enameller charged the company with breach of their agreement, until he was shown the envelope still sealed in the safe.

Use of Boric Oxide

A MEMBER said he could not deny there were losses of boric oxide and sodium oxide during smelting, but he did know that the addition of quite small percentages of boric oxide could prevent the loss of some chemical constituents of glasses. Selenium was used for decolourising glasses, and the addition of 1 per cent. of boric oxide to a white flint glass would reduce the amount of selenium needed by 50 per cent. The explanation was that the borax gave quicker melting, so that the selenium became more easily diffused throughout the batch and consequently less was lost. He thought that similarly applied to other constituents as well. In making coloured glasses, if boric oxide was used, frequently less colouring oxide was needed.

Enamelling Stainless Steel

MR. RYDER asked whether Mr. Abbott thought the inflexion in the expansion curves had anything to do with the change of crystal structure of silica which occurred about 300 deg. C., the temperature where the inflexion took place. A point which occurred to him with regard to the question of the oxide taken up from the surface layer into the ground coat was whether any experiments had been made with additions of iron oxide to the ground coat to see what effect they had on the expansion. It also occurred to him that some interesting results might be obtained if attempts were made to enamel a metal which would not easily oxidise, say, 18:8 stainless steel. Would the results be similar to those in a nitrogen atmosphere? It seemed to him that the question of iron oxide taken up was rather important, and well worth more investigation.

MR. ABBOTT replied that he did not know what other enamellers felt about the question of the change in state of the silica, but he thought perhaps the Chairman would agree that all the silica in the frit was combined as silicates.

The CHAIRMAN: I should think so.

MR. ABBOTT, continuing, agreed that the solution of iron oxide in the ground-coat was a very important happening. Dietzel and Meures had published results on the effect of expansion of iron oxide additions to the ground-coat enamel, and also had determined the iron oxide concentration in enamel layers at different distances from the surface of the metal. Their Paper had been translated and published in the Journal of the American Ceramic Society for 1935.

Regarding Mr. Ryder's suggestion of enamelling 18:8 steel, Mr. Abbott said it was actually his experience that polished stainless steel could not be enamelled. No oxide was formed, and the metal, like platinum, appeared unwetted by the melted enamel. If, however, the polish was removed by sand-blasting, quite good adhesion was obtained with a cobalt-free enamel.

Moduli of Elasticity

MR. BARTON wondered whether Mr. Abbott had any data on the moduli of elasticity of the various enamels, because, as he saw, they had an important bearing, in the same way as viscosity measurements, on the physical properties of the enamel. Mr. Abbott, although he went into great detail about the viscosity, had skated over elasticity. Were any figures available for enamels actually in use to-day?

MR. ABBOTT agreed that he had skated over the subject of elasticity. There had not been time to deal in detail with every aspect. The subject was a most important one, and had a bearing on impact and bending resistance. A few measurements of the elasticity, tensile strength and compressive strength of enamels had been made, but the results available did not agree very well. A. I. Andrews in his book gave some figures, and also described experimental methods. The National Bureau of Standards at Washington had determined more recently the elasticity of a number of sheet-iron ground-coat enamels. Their values all fell between 8,200 and 8,400 kg. per sq. mm. It had, of course, to be remembered that the values would probably be very different for an actual enamel loaded with gas bubbles.

Mill Room Practice

Mr. A. G. Read's Paper on "Mill Room Practice," presented to the Northern Section of the Institute of Vitreous Enamellers, and published last week, was the subject of an interesting discussion by the members. The principal points are given in the following report.

MR. H. BRADLEY said that the Paper was of an eminently practical type, founded upon the author's own experiences. Mr. Read had touched on the trouble involved in the sieving and the fineness test. Would he further explain the difficulty of testing the enamel for fineness while in the wet state?

Fineness Tests

MR. READ said that in taking a fineness test one first procured a 50-ml. aluminium pot with a hole in the side, thus providing for a definite quantity. The enamel was taken from the mill in the normal way and was poured into a 150-mesh or a 200-mesh sieve. The clay was washed out together with all the other mill additions, just as if it was going to be dried.

As Mr. Hansen had explained in his Paper, there was nothing better than this system of taking a fineness test. To the speaker's mind, it had always appeared to be a haphazard procedure to have to rely on a piece of gauze of, say, 200 mesh, which could so very easily be damaged. He had gone into numerous mill-rooms where nothing could be adjudged correct, and pursued his inquiries until he came to the sieve which had been used, when he would find it stopped up all round the side, and useless for making tests. Consequently, the enamel was not of the fineness it was thought to be.

Returning to the test, the enamel was washed through exactly the same way. After all the clay and the oxide and the mill additions had been washed out, instead of drying it one tapped the sieve until the enamel was at the bottom. Then a 30-ml. glass, provided with a good-sized neck, was taken, and the sieve was placed on top of it. The water was allowed to run gently on the back of the sieve, thus gradually washing the enamel into the bottom of the measuring glass. It naturally gathered very quickly on the bottom. It was found that when the enamel was washed through the sieve and dried it increased the bulk. Two units of weight in the 30-ml. glass were equal to four units of weight in the ordinary measuring glass after the enamel had been dried.

There was another side to the question, that of comparability. Suppose, for instance, one was working with a furnace and the pyrometer was not too satisfactory. Very good loads correctly fired might be obtained, although the pyrometer

showed 800 deg. C., and at the same time one knew, from the appearance of the furnace itself, and from experience of works practice, that the temperature was not 800 deg. C. So long as the furnace did the work satisfactorily, what did it matter what the pyrometer recorded? Even if it read only 600 deg. C. it was a guide to the eye—a comparative guide. The same thing obtained with the screen test. The idea of testing in the wet state was the economising of sieves; if no drying occurred, the sieve always remained in good condition when the test was taken.

Sodium Nitrite Additions

MR. H. JUKES asked what was the best percentage of nitrite of soda to use, and whether it should be added dry or wet, as mill additions, or after milling the enamel.

MR. READ recalled a recent difficulty in connection with the use of nitrite of soda. The man in one milling room made some enamel in which nitrite of soda was used as a rust preventive. Afterwards, he ground some more enamel, and in the mill used a quantity of carbonate of magnesia. He then added to the first enamel some of the enamel which contained the carbonate of magnesia, and a definite frothing occurred instantly, which would not subside.

In using nitrite of soda as a rust preventive, Mr. Read always dissolved just the quantity considered necessary. The same remark applied to the use of Epsom salts. A quarter of 1 per cent. to 100 parts of enamel was ample. If it could be excluded, so much the better. Additions of all such things in the mill tended to increase enamelling trouble.

Scrapings and Rust Spotting

MR. JUKES asked whether the use of an excess of scrapings would cause rust spotting.

MR. READ did not think that condition would cause rust spotting, but it might help to aggravate it. Rust spotting was set up by the actual effect of spraying the water on to the iron. Other factors would aggravate rust spotting, but the mere use of scrapings would not necessarily cause it.

MR. W. H. WHITTLE remarked that, in an enamelling shop, Monday morning was about the worst period of the week, until the shop attained a natural temperature. In order to avoid rust spotting, if the shop were cold, it was essential to get the work to the drier more quickly than when the shop was at normal temperature. This applied no matter what was added, and whether the work was sprayed or swilled, and if it was ground coat it was generally dipped. Some driers operated at too low a temperature, while condensation was another factor in connection with rust spotting. A Paper read previously had recorded that a certain firm had had trouble with rust spotting; but when they took the roof off the drier the rust spotting ceased, because the condensation had been eliminated.

Many faults ascribed to mill room practice could be described definitely as shop troubles outside the province of the mill room. Would Mr. Read indicate how long ground coat should be left lying about before it was fused? He had heard it said of one of the largest enamelling plants in the country that there were far fewer rejects when dealing solely with sheet work by firing within nine hours after dipping. Exceeding that period certainly involved fusing troubles.

Night-Shift Firing

MR. READ said that in the hollow-ware trade it was a common practice to fire during the night shift. In consequence, sometimes some of the ground coat which was dipped one day was left over until the following day, and was not fired until the next night. Thus an interval of 24 hrs. elapsed before firing. When firing ground coat (especially sheet-iron ground coat), as soon as it was dry the sooner it could be fused the better. He thought, however, that more trouble was caused in sheet enamelling through allowing the work to lie about after the ground coat had been fired.

MR. W. H. WHITTLE raised the question of the white coat and the colour coats. It was understood among the older enamellers that the sooner each coat was fired the better. Dealing with shop atmospheres, on Monday mornings or after holidays some enamels would definitely stand for a long time for the next treatment, whereas others required covering for the next operation as soon as possible after fusing.

Allocating the Trouble

MR. READ inquired whether Mr. Whittle would associate the trouble with the enamels or the irons. If some P.C.R.A. and some C.A. material was being run through the shop at the same time, using similar enamel on both, did Mr. Whittle experience greater trouble with the poorer quality of sheet, if it stood about too long, than with a better quality of sheet?

MR. W. H. WHITTLE thought the former would be the case.

MR. READ, voicing a similar opinion, thought it would be possible to enamel a high-grade sheet and allow it to stand about with less risk than there would be in the case of a hard, cold-rolled steel. The latter could not be allowed to stand very long before trouble occurred.

MR. W. H. WHITTLE said that, dealing with ground coat, and in fact other coats, the enamel was porous to a certain extent and would absorb moisture. It might be that a certain amount was absorbed and this moisture was not thoroughly dried out when the next coat was put on. It would have got into the pores of the enamel.

MR. READ, agreeing, said he thought most of the Midland members were now of the opinion that it was possible, with sheet iron especially, to enamel a piece in ground coat, and to all intents and purposes it would appear to be satisfactory. The white was then put on and was still good. Afterwards it was possible that it would absorb something from the atmosphere which would cause fish-scaling. He thought that was now admitted, because examples had been submitted by members in the Midland Section.

Press-Shop Oils

MR. W. H. WHITTLE referred to another trouble for which the mill room had been held responsible in the case of certain stampings or pressings for enamelling. A shop which made its own blanks and did its own enamelling procured the correct sort of oil, either mineral or vegetable, in order to suit the subsequent pickling process. He was speaking now mainly for the benefit of jobbing enamellers who received blanks from various firms who used different solutions, ranging from "soap and water" to the mineral and vegetable oils. In the case of articles which had been fabricated under very heavy presses, some of the substance became pressed into the pores, and even grease-burning or the ordinary pickle could not remove it.

MR. READ said that probably the only remedy would be to de-scale it.

MR. W. H. WHITTLE said that was reverting to the old method—he would not say it was the only one—of a very strong wash followed by pickling.

Bellied Saucepans

MR. READ recalled a visit to a hollow-ware works where they made bellied saucepans, which were a difficult job to do at any time. The operation of making the first pressing work-hardened the material to such an extent that they had to de-scale it. It was not just annealed, but actually de-scaled after the first drawing.

MR. W. H. WHITTLE said that the de-scaling process definitely got down to the body of the metal and made for a clean job.

MR. F. EGERTON said that contact might be made with press shops regarding the use of oil.

MR. W. H. WHITTLE observed that some firms sent out their work and received blanks from diverse sources, and then sent them to the jobbing enamellers, who did not really know who had made the blanks in a number of cases.

MR. EGERTON suggested that the press shops really did not know whether they had the right oil or not. Perhaps there should be more co-operation with the enamelling shop and information given as to the correct type of oil to be used.

MR. W. H. WHITTLE agreed that co-operation was necessary.

MR. EGERTON had not heard of C.A. sheets being used for vitreous enamelling. Some shops used C.R.C.A. because of price, while others used P.C.R.C.A. He thought it was generally found that steel sheets were used mainly for mottled ware, the mottle hiding much of the defects. In his experience, where a man had to produce a self colour, he used an ingot iron.

Steel for Enamelling

MR. W. BALL said he was under the impression that an enameller was judged in many instances by the quality of steel he was willing to enamel, coupled with a low percentage of rejects. It seemed to be accepted that the better the enameller the cheaper the steel or iron which could be bought for him. There certainly was a good deal of cheap iron and steel being used nowadays. Enamels were now being judged in the same way, both on steel and on cast iron.

MR. W. H. WHITTLE said that for two, three, and possibly four-fired work, such as mottle up to white, some people did use steel. With a greater number of firings, however, steel would not stand up to the treatment. It lost its nature, whereas the specially-prepared iron was made to go up to ten or a dozen fires, or perhaps even more than that.

MR. EGERTON thought that Mr. Read would agree that steel sheets could make a very good job. With two coats of white, they might be successful for three months, and then, suddenly, there might be a batch which went wrong, due entirely to some inconsistency in steel sheets. Makers would not guarantee to keep to the same analyses over 12 months. The real advantage with ingot iron was that it was pure, or practically so; it made a consistent sheet, and one delivery was the same as another at any time. One did get uniform results all the year round with an ingot iron sheet.

MR. WHITTLE: Except where the human element enters.

Radius of Bends

MR. EGERTON, agreeing, recounted an experience of a man having trouble with crazing and chipping on a panel he was sending out to a jobbing shop. It was bent to an angle of 90 deg., and the corner of the bend had practically knife-edge sharpness. He wondered why he was getting trouble! Some time ago the enamelling trade was advised that the minimum radius which should be used on any bend was nine-tenths of an inch. Below that minimum one was liable to get trouble. That advice was given as the result of very exhaustive tests with the enamelling of all kinds of bends.

The CHAIRMAN (Mr. H. Whitaker) asked how Mr. Read adjusted his enamelling conditions in different parts of the country where there might be great differences in the quality of water available.

MR. READ said that the water was exceptionally hard around the London area, and quite large amounts of borax were used advantageously in grinding. When grinding the ground coat, if the water was hard, there was no need to be afraid of stepping up the borax. On the other hand, in a district like Birmingham where the water was soft, the use of borax could be entirely dispensed with. Using hard

water, borax was a great help, especially for the ground coat, not merely with regard to the enamel itself, but also in regard to the dipping. It would help the slip to run properly and to grip actually while it was being dipped, and it gave a better result when it was fired because it could be put on evenly.

Sizes of Grinding Balls and Mill Wear

MR. A. J. BIDDULPH asked what Mr. Read thought about the relative sizes of either balls or pebbles in the mill. His own experience had shown that certain sizes were good for certain sizes of mill. Some mill makers specified sizes much smaller than those he had found to give good results. In one case an enameller complained that his enamel was not grinding properly. Examination of his sieve revealed a hole through which one could stick one's fingers. This accounted for the bits of frit in the dipping tank. He was using a 200-lb. mill with pebbles up to an inch in diameter. It was pointed out that his pebbles were too small, and that they should be increased to 2 in. The enameller declared he would not change them, because he had started with 2-in. pebbles, but they had destroyed the mill lining in about a couple of months. The mill had to be repaired, and the makers then told him that he was not to use such large pebbles again. Had Mr. Read any decided opinion concerning the relative merits of either porcelain balls or flint stones?

The remarks concerning the rubber stopper were interesting. Sometimes one could save mill wear by renewing the stopper frequently, so that the face which was to the middle of the mill projected slightly above the mill lining. This took the "bump" and the wear, and could be renewed much more easily and cheaply than the mill lining.

How often should pebbles be inspected, and had Mr. Read experienced trouble in replacing pebbles in the mill? Mr. Biddulph had seen two mills in a Lancashire factory where the mill lining had begun to wear not at the mouth of the mill but immediately opposite. He thought this was due to the procedure of taking the pebbles out, and dropping them in again through the funnel with the mouth of the mill uppermost. The pebbles in use were of about 2 to 3 in. in size, and they were dropped some 3 ft. on to the lining blocks opposite the mill mouth. Probably 200 pebbles would hit the one place before there was a sufficient number to break the fall.

Time and Colour Deterioration

A point had been raised concerning enamel deteriorating during a long period of standing. He thought some of that deterioration could occur through the presence of certain oxides. A nice bright red or light green enamel which normally fired up very well, if left over the week-end would sometimes give a very poor result. This was probably due to the absorption of atmospheric moisture.

Many cheap oils were in use for press work. These contained such adulterants as talc and barium carbonate, which were used in some cases to lower the price of the oil, although they were not very good for pressing, and a potential cause of trouble in enamelling.

Porcelain Balls *v.* Flint Stones

MR. READ thought that if a 200-lb. mill was loaded with 2-in. stones, and an appropriate amount of enamel was put into the mill to be ground, the stones would not damage a mill of that size. He had always maintained that it was possible to do more harm to a mill by running it light than by using large stones. The mill could be filled with half-bricks provided there was sufficient frit and other material to it to take the bump.

Speaking of porcelain balls *versus* flint stones, Mr. Read said that at the present time two mills were running side by side, one equipped with porcelain balls and the other with flint stones. The porcelain-ball mill was being run with two sizes of balls (1 in. and 1½ in. he thought). A similar weight of grinding medium was in the mills. He had found repeatedly that the porcelain balls ground more quickly. He could not account for this result, but it went to prove that the porcelain balls were providing more grinding spaces actually. The flint stones were weighed once a month. So far, the porcelain balls were losing weight much faster than the flint stones.

Assuming good mill room practice, he had always found that the wear of the mill, when the stopper was kept even with the inside of the mill, was at the sides of the mill where it ran on to the flat. A groove was started round the inside of the mill, the place where the real wear occurred. If the stopper was kept down well inside the mill, it would be found that the stones gradually chipped. The actual wear did not really occur there. Bright red or other enamels should never be left standing over a week-end.

MR. W. H. WHITTLE said that it was an old custom that men should fire off all the colour before ceasing work.

MR. READ had been told that in America enamellers did not trouble about the speed of the mills, provided the mills did not become hot. This did not seem to be good practice to him.

MR. H. W. WHITTLE observed it was an entirely wrong impression. He had seen American enamellers testing the speed of mills. They had charts to indicate each day the amount of material they put into mills, and the actual speed at which the mill was running.

MR. W. H. WHITTLE expressed a preference for pebbles to porcelain balls. The mills should be correctly loaded in order to produce a cascading effect, and they should be run at definite speeds.

MR. READ added that, naturally, the larger the mill the slower would be the speed.

United States Production of Pig Iron & Ferro-Alloys

Statistical Bulletin No. 4/1939 of the American Iron and Steel Institutes reports on the production of pig-iron and ferro-alloys in the United States in the first six months of the current year. The tabulated statistics issued show that pig-iron production was 12,313,366 gross tons in that period, as compared with 7,778,964 tons in the first half of 1938 and 10,767,106 tons in the second half of that year.

The principal producing States in January to June last (and July to December, 1938, in parentheses) were: Pennsylvania, 3,226,688 (2,713,160) tons; Ohio, 2,808,608 (2,609,040) tons; Michigan, 1,712,517 (1,383,287) tons; Alabama, 1,230,508 (1,153,065) tons; Maryland, West Virginia, Kentucky, Tennessee, 1,148,924 (1,047,797) tons; Illinois, 1,077,098 (947,860) tons; and Massachusetts and New York, 819,295 (730,618) tons. The total output of pig-iron in the two periods included: Basic pig-iron, 9,173,457 (7,726,056) tons; Bessemer and low-phosphorus pig-iron, 1,903,076 (1,730,175) tons; foundry pig-iron, 753,670 (822,346) tons; and malleable pig-iron 454,029 (475,036) tons.

The production of ferro-alloys in blast furnaces and electric furnaces totalled 343,576 tons in January to June last, compared with 325,057 tons in January to June, 1938, and 289,734 tons in July to December last. The output in January to June of this year included 147,122 tons of ferro-manganese and spiegeleisen and 174,579 tons of ferro-silicon.

Of the 223 blast furnaces built on June 30 last, 114 were in blast on that date making pig-iron, as against 107 on December 31, 1938.

A New Hand-Press Moulding Machine

Details are given below of a new British-made moulding machine, the sole distribution of which is undertaken by W. J. Molineux (Foundry Equipment), Limited, Bhylls Lane, Wolverhampton. It is a straight hand-press direct-draw machine made in two sizes designated HT1 and HT2. The smaller capacity machine has a 4-in. pattern draw, and takes boxes up to a maximum width of 16½ ins.; the maximum clearance for double-sided plates is 4⅛ in. and the maximum width opening 10¾ in. The larger one has a 5-in. pattern draw and the other dimensions are correspondingly larger.

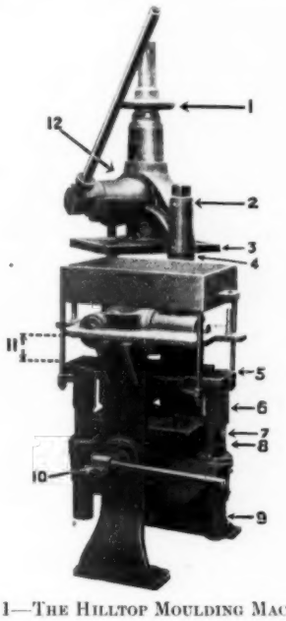


FIG. 1—THE HILLTOP MOULDING MACHINE.

The machine is being largely used for the production of iron, brass and light alloy castings. The pressure head is operated by means of a crank and lever which gives a progressive action, greater pressure being exerted on the mould toward the bottom of the stroke. The hand wheel (Fig. 1—(1)) is used for varying the position of the pressure stroke for different depths of boxes. The head is hinged on a heavy steel shaft, at the bottom of which is situated a ball thrust (4) to minimise friction. The pressure plate (3) is of generous dimensions and forced lubrication is provided for the moving parts at points (2) and (12).

The pattern draw is operated by means of a slow-motion cam through a lever (10). At the beginning of the operation the motion is slow, but it is accelerated as the mould leaves the pattern. The lifting table (5) is now mounted on two heavy shafts (eccentrically turned at the fixed end so as to enable adjustments to be made). In turn these work in long cast-iron renewable sleeves (8) which are forced-lubricated from point 7. The shafts are enclosed by two steel aprons (6) to prevent sand from reaching the bearing surfaces. The bottoms of the shafts are totally enclosed by caps (9).

The capacity of the machine is enhanced because the hinged tie bar does not limit the length of the box that can be used on the machine. Ample clearance is provided for double-sided plates as shown at 11.

EMPLOYEES of the Broken Hill Proprietary Company at the Newcastle steelworks, New South Wales, will have their pay increased by an industrial award. It is the first general award granted since 1925.

The Week's News in Brief

Trade Talk

THE INSTITUTION OF STRUCTURAL ENGINEERS announce that their official address is now "Cornerways," Speen, Aylesbury, Bucks.

THE CUTLERS' FEAST at Sheffield, which the Prime Minister was to have attended as chief guest, will not be held this year.

THE BOARD OF TRADE announce that all communications for the Export Licensing Department, hitherto at 80-82, Pall Mall, should be made to Inveresk House, Strand, London, W.C.2.

ASSOCIATED BRITISH MACHINE TOOL MAKERS, LIMITED, have removed from 17, Grosvenor Gardens, London, S.W.1, to the Manor House, Beaconsfield Road, Claygate, Esher, Surrey.

THE SUBSTITUTION of trolleybuses for electric tramways in Italy is providing a supply of old tram rails as scrap. The 45 km. of track in Rome is furnishing 2,290 tons of rails and 230 tons of other metal.

THE AMALGAMATED ENGINEERING UNION announces a membership increase for last month of 2,663, making a total of 390,873. The unemployed total of 5,186 represented a decrease of 108.

THE CENTRAL PROVINCES MANGANESE ORE COMPANY, LIMITED, announce that, until further notice, the registered office of the company will be at 25, Christchurch Park Road, Sutton, Surrey.

WILLIAM JACKS & COMPANY, LIMITED, have arranged for their business to be temporarily conducted from the residence of their chairman at 3, Broadlands Road, Highgate, London, N.6.

THE shareholders of Thomas & Clement, Limited, Llanelly, have approved the scheme for amalgamation of interests with the Glanmor Foundry Company, Limited, another well-known Llanelly engineering firm.

THE BRITISH ALUMINIUM COMPANY, LIMITED, will be removing their head office from Adelaide House, King William Street, London, E.C.4, to new and larger quarters at Norfolk House, St. James's Square, London, S.W.1, as from September 18.

WORK has been continuing for some months on the Otanmäki iron-ore deposits near Vuolijoki in Finland. The ore field is on State-owned land. The investigations have given good results, although the quantity of ore at present cannot yet be determined, and serious transport difficulties have to be overcome.

THERE WAS a sharp contraction in the Tees imports of iron and steel last month, which totalled 9,752 tons, compared with 21,796 tons in the previous month. The August total comprised 9,114 tons of steel semis (July, 20,886 tons); pig-iron, 556 (786) tons; and finished steel, 82 (154 tons).

THE NAME of W. Edward Kochs & Company, Limited, 14, Park Lane, Sheffield, 10, has now been changed to W. E. Cox & Company, Limited. All communications should be addressed to the company under the new name. Trading activities will be continued in exactly the same manner as hitherto.

TECALEMIT, LIMITED, held their sports day on Saturday, September 2, at the Polytechnic Stadium, Grove Park, Chiswick. A large and enthusiastic gathering of employees and their relatives and friends were present to witness 30 events, including all popular flat, hurdle and field items for both sexes. Mr. R. A. Chalmers, managing director of Tecalemit, Limited, and president of the Sports and Social Club, was present with his co-directors, Mr. W. J. Parslow and Mr. A. Sewell.

A CONTRACT for thirty-six 60-ton ore-carrying wagons has been received by Hurst, Nelson & Company, Limited, Motherwell, for despatch to Turkey. This is part of an order for 300 wagons placed in this country by the Turkish Government for use in the new steelworks at Karabuk. The bulk contract was negotiated by the Metropolitan-Cammell Carriage, Wagon & Finance Company, acting for British rolling stock manufacturers. Financing has been arranged under the recent Anglo-Turkish Guarantee Agreement. The whole contract is worth over £500,000.

CIRCULARS have been despatched to preference and ordinary stockholders of the Stanton Ironworks Company, Limited, who have not yet ratified the merger contract with Stewarts and Lloyds, Limited, in which the directors repeat the terms of the exchange of stock and direct attention to its advantages. Such stockholders are invited to complete and return forms of ratification not later than September 15. The merger contract has already been ratified by holders of substantial majorities in value of both classes of stock in the company.

A REPORT that 200 employees had been dismissed by Irish Steel, Limited, from the works opened at Haulbowline by the Eire Minister for Industry and Commerce, because of the international crisis, was denied by the managing director, Mr. A. S. Huxley, in an interview. The number of men affected, he said, was 130, and they were mainly unskilled workers engaged for certain constructional operations now completed. The work of the merchant mill was not interrupted, and production was proceeding normally. There was no shortage of raw material for that work.

THE following arrangements are notified in connection with the operation of the Anglo-Spanish, Anglo-Roumanian, Anglo-Italian and Anglo-Turkish Clearings during the period of the present emergency. Payments of all debts to which the Treasury Orders apply will continue to be made in the ordinary way to the Bank of England for the account of the respective Clearing Offices. Clearing Office receipts will continue to be a good discharge as regards the amounts paid. Receipts will be issued as early as practicable, but some delay may be inevitable. Requests for telegraphic transfers cannot at present be entertained. Advance payments will continue to be accepted. It is essential that they should be clearly described as such. Payments by the Clearing Offices to United Kingdom creditors will continue to be made, though some delay may be inevitable.

THE Minister of Transport has made orders under the Emergency Powers (Defence) Act, which will have the following effect:—(1) Any operator of a goods vehicle may use for the carriage of goods of all classes for hire or reward or for the purpose of any trade or business carried on by him any vehicle (*a*) which is specified in a current carrier's licence under the Rail and Road Traffic Act, 1933, and carries a valid identity certificate; (*b*) which is not specified in a current carriers' licence, but carries a certificate in a prescribed form issued by a Regional Transport Commissioner. This general relaxation of the conditions attached to carriers' licences may be withdrawn or modified either generally or in particular cases. The general object of these provisions is to remove restrictions on the carriage of goods by road which would be inappropriate under war conditions.

THE Minister of Supply has made an order entitled the Priority of Work Order, 1939, under which contractors and other persons will be required to give priority to certain work carried out in their factories, workshops, and elsewhere in accordance with priority orders issued to them by officers of departments concerned. It is not at present the intention that these priority orders shall cover the whole field of indusry, but only that proportion where definite difficulties are experienced in meeting essential supply requirements, either for the general needs of the nation or for the requirements of specific Government Departments. Contractors who experience difficulty as regards labour or material or otherwise in fulfilling their contracts should get in touch with the Government Department concerned with the particular branch of industry, or, in the case of Government orders, with the Department which has placed the contract.

MR. PERCIVAL SMITH, of the Birmingham Education Department, addressed the Psychological Section of the British Association on "The Selection of Skilled Engineering Workers." He described what is being done by the Education Committee in Birmingham to help young people in their choice of a suitable career, and how tests have been applied to various groups of boys to gauge their mechanical aptitude. It might be claimed, he said, that as a result of these investigations, which had been spread over a period of eleven years, evidence had been obtained which showed that a battery of mechanical aptitude tests was more prognostic of success than was an academic examination in selecting boys for a junior technical school course and also in selecting boys for recruitment to the skilled ranks of the engineering trades. As a result of these investigations, the Education Committee had incorporated certain mechanical aptitude tests as a part of the ordinary entrance examination to junior technical schools in Birmingham.

Personal

MR. T. M. MACQUAKER has been elected to the board of the Scottish Stamping & Engineering Company, Limited.

MR. JOHN LEWIS has been appointed to the board of the Whitehead Iron & Steel Company, Limited. He has been associated with the company for many years.

MR. LEONARD SATCHWELL has resigned from the board of the Harland Engineering Company, Limited. Mr. Wilson Harvey has been appointed a director.

MR. F. C. YAPP, director of Vickers, Limited, and Vickers-Armstrongs, Limited, has been appointed to the position of deputy-chairman of Vickers-Armstrongs, Limited.

MR. M. MELHUISH has resigned from the board of the Glacier Metal Company, Limited. The vacancy has been filled by the appointment of Mr. P. J. Flaherty, president of the Johnson Bronze Company (U.S.A.).

MR. G. W. DAGLISH, the honorary secretary of the London Branch of the Institute of British Foundrymen, being a territorial soldier, has been called up for service.

MR. JOHN ROXBURGH, foundry manager of Davy & United Engineering Company, Limited, Sheffield, has received an appointment with Ley's Malleable Castings Company, Limited, of Derby. He takes up his new position on October 1.

MR. S. LEETCH, of the Foundry Department of Edgar Allen & Company, Limited, Sheffield, has been appointed works manager of the Haverton Hill Works, near Middlesbrough, of Davy & United Engineering Company, Limited. His appointment dates from October 1.

MR. ASHLEY SKELTON WARD, who has been elected Master Cutler of Sheffield, is the son of the late Mr. Herbert Ward, of Birley Carr, and a nephew of the late Mr. T. W. Ward and of Dr. Joseph Ward, both former Master Cutlers. He commenced his business career with the firm of which he is now joint managing director. At a youthful age he went to London to promote the business of Thos. W. Ward in the Southern area, and subsequently established and developed the extensive Silvertown and Grays Works. In 1922 he returned to Sheffield to take a prominent part in the administration of Thos. W. Ward, Limited, and is particularly interested in the dismantling and industrial properties activities. He materially helped in the resuscitation of concerns like the Laycock Engineering Company, Limited, Sheffield; Marshall, Sons & Company (Successors), Limited, Gainsborough; Low Moor Best Yorkshire Iron, Limited; Widnes Foundry & Engineering Company, Limited; and the Darlington Railway Plant & Foundry Company, Limited. He was responsible for the purchase by his company of the Palestine pipe line—32 miles long. He is actually engaged in the direction of a large number of the associated and subsidiary companies. He has for some years been President of the Federated Associations of Scrap Iron, Steel, Metals and Machinery Merchants of Great Britain, and he took an active part in the formation of the Central Scrap Agency of the British Iron and Steel Federation.

Obituary

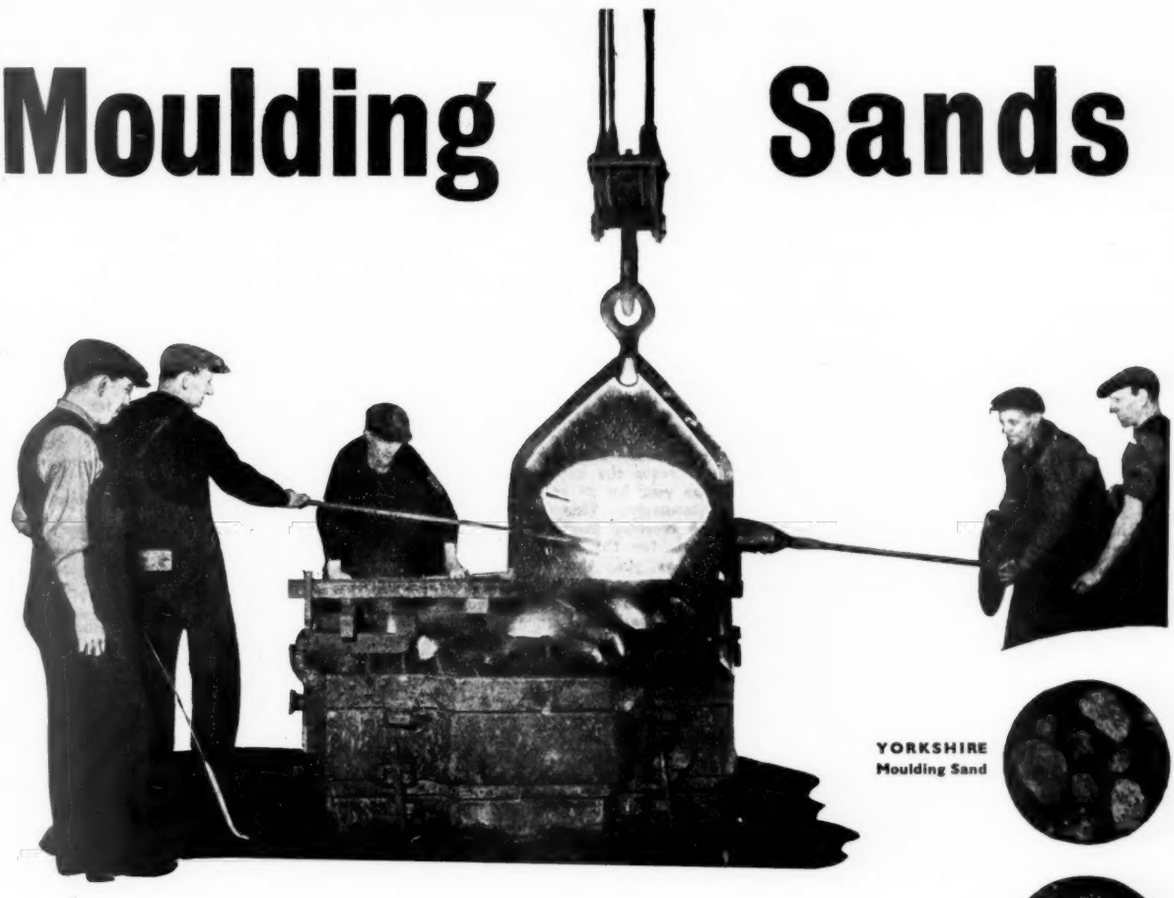
WE REGRET to announce the tragic death of Mr. Fernand Grospierre, of Mezières, France, who was shot by a discharged workman. He was for many years on the staff of the Allied Machinery Company of France, a concern which handled the Osborn moulding machine. Since 1927 he had been general manager of the Clement Bayard concern at Mezières, which manufactures motor-car castings.

Railways Under Control

The Minister of Transport has made an order taking control of the undertakings or portions of undertakings in Great Britain wholly owned by, leased to or operated by any one or more of the Railway Companies in the United Kingdom.

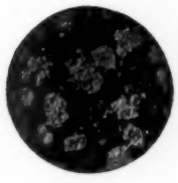
A Railway Executive Committee has been appointed, consisting of—Sir Ralph Lewis Wedgwood (chairman), Sir James Milne, Mr. C. H. Newton, Mr. Frank Pick, Mr. Gilbert Savil Szlumper, and Sir William Valentine Wood.

Moulding Sands



YORKSHIRE
Moulding Sand

THANET
Moulding Sand


YORK YELLOW
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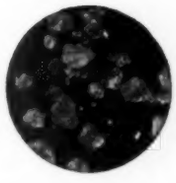
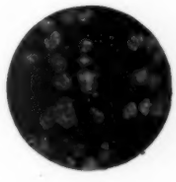

ZENITH
Moulding Sand


MANSFIELD
Moulding Sand

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Raw Material Markets

Full details of the control now exercised over the iron and steel industry by the Government were given in our last issue, when the new licensing scheme was outlined, and the names and addresses of the control officers are given in page 15 of this issue. For some time past the industry has been working in close collaboration with various Governmental departments, and the new control has thus been effected with expediency. In industrial circles generally it is felt that the choice of Sir Andrew Duncan as Controller of Iron and Steel was a happy one in view of his many services in the past, especially in connection with his work as chairman of the British Iron and Steel Federation.

Pig-Iron

MIDDLESBROUGH—Ironmakers in this area have for a considerable time past been almost solely engaged on the production of material other than foundry iron, for which there has been but a small demand. Under Government control, it is anticipated that there will not be any change in this position, and consumers of foundry iron will mostly continue to obtain their requirements from other districts. The hematite trade remains busy, and users are calling for early deliveries of substantial tonnages. Production is at a high level, but there are ample supplies to meet consumers' orders. With export trade negligible, the efforts of hematite makers are being concentrated on the satisfaction of home requirements.

LANCASHIRE—The establishment of Governmental control came as no surprise to industrial concerns in this area, and it is appreciated that the priority arrangements which have been made will only allow the demands of commercial users to be met after more urgent needs have been relieved. Good stocks of foundry iron are available, and the call for deliveries in recent weeks has been on quite a good scale. Naturally there has been little disposition of late to book new business.

MIDLANDS—There has been an understandable reluctance on the part of iron producers to accept new business in view of the fact that as from September 1 all supplies of iron and steel came under the control of the Ministry of Supply. High-phosphorus iron is in stock in large tonnages, as recently there has not been any substantial buying movement, on account of the light-castings trade being quietly placed for work. Both low-phosphorus iron and hematite have been in insistent demand for a considerable time past, but consumers' requirements have been met.

SCOTLAND—The outbreak of hostilities and the consequent reorganisation of the foundry iron trade have resulted in less business being conducted of late, but stocks are available from which consumers' demands may be met. There has been a noticeable improvement in the position of light-castings works recently, while the heavy ironfoundries continue to be well employed. Hematite and basic iron are being used in large quantities by local steel plants.

Steel

Steelmakers will in future have to devote their attention to the needs of the Government and commercial requirements will thus become secondary. This has, in fact, been the case for many months past. Commercial users, including public-utility undertakings, will now have to obtain licences for supplies of steel. Heavy supplies have been taken up by defence projects, and it may be expected that these demands will be increased in the near future. Works, on the whole, are in a position to give satisfactory deliveries, as production has been on a good scale for a long time past, and additional plant is being brought into operation.

Scrap

Merchants have not been too willing to add to their commitments since the outbreak of war, but there is a ready demand waiting to be relieved. It is unnecessary to procure licences for sales of iron and steel scrap to home users, but permits must be obtained from the Export Licensing Department of the Board of Trade before transactions are arranged with overseas consumers.

Metals

Recently tin has been the only metal in which dealings were allowed on the London Metal Exchange, and only fifteen minutes, from noon to 12.15 p.m., was reserved every day for business. But on Wednesday it was announced that no further business would be permitted in tin before Monday next, as a result of Government intervention. Dealings in tin have been exceptionally brisk, and the daily turnovers have been quite substantial. As a result, the price of three months' tin has become firmer. Supplies are freely available in this country. In the United States, there has been marked activity, with consumers pressing strongly for supplies. The price has advanced very steeply.

The International Tin Committee decided on Tuesday to increase the export quota for the third quarter of the year by 20 per cent. to 80 per cent. of standard tonnages. This decision supersedes the announcement recently made that the quota would be 60 per cent. for the third and fourth quarters of the year; as yet, the decision for the final quarter of the year stands, but a further announcement is likely to be made. The quota at 80 per cent. is at the highest level since December, 1937.

The Minister of Supply has now issued the Control of Non-ferrous Metals (No. 2) Order, 1939, under which the schedule of maximum prices attached to the Control of Non-Ferrous Metals Order, 1939, dated September 1, 1939, is cancelled, and a revised schedule is substituted therefor. Apart from minor adjustments in the maximum prices specified in the previous order, the main effect of the revised order is to clarify the position as regards the premiums or other charges which may be made in accordance with the usual trade practice for deliveries elsewhere than at the points specified.

Chief among the tasks of the Controller will be the mobilisation of Empire resources, and ensuring that supplies do not seep through to the enemy *via* neutral countries. Control of consumption of non-ferrous metals in Germany has been exercised very severely for a considerable time past and, while substantial supplies may be on hand for use by the Reich, reserve stocks will have to be expanded if Germany is to continue to have adequate quantities at her command for the prosecution of war.

The Minister of Supply has also issued the Control of Aluminium (No. 2) Order, 1939, dated September 9. This Order makes the sale and purchase of aluminium and aluminium alloys situate in the United Kingdom subject to a licence granted by the Minister of Supply. On and after September 23 the use of any such material for the purpose of any manufacture or work will similarly require a licence. Applications for such licences or for any information in regard thereto should be addressed to "Ministry of Supply, Aluminium Control, Raven Hotel, Castle Street, Shrewsbury."

Mr. W. H. Gartsen (Henry Rogers, Sons & Company) announces that the total visible supply of tin on August 31 was 20,335 tons, against 22,654 tons on July 31. The carry-over in the Straits Settlements was 1,677 (2,167) tons, while the carry-over at principal European smelters (other than the British Tin Smelting Company) was 3,455 (3,570) tons.

Schedule of Maximum Prices

The following prices have been announced as maximum quotations under the control of non-ferrous metals:—

Copper—Rough, £46, in warehouse; refined, £49 10s., in warehouse; electro, £51, c.i.f. U.K. ports; billets, £55, c.i.f.; cakes, £51 12s. 6d., c.i.f.; cathodes, £50 10s., c.i.f.; wire rods, £55, delivered.

Lead—Soft foreign, £16 12s. 6d., ex-ship; Empire, £17 5s., ex-warehouse, duty for buyers' account; Empire, £17 ex-ship, £17 12s. 6d. ex-warehouse, duty for buyers' account.

Spelter.—G.O.B., foreign, £15 ex-ship, £15 12s. 6d. ex-warehouse, duty for buyers' account; Empire, £17 5s. ex-ship London; Empire, including domestic, £17 17s. 6d. ex-warehouse, £17 5s. f.o.r. Swansea/Avonmouth; high-grade, £18 c.i.f. U.K., £18 12s. 6d. ex-warehouse; zinc sheets, 10g. and thicker, £29 ex-works; rolled zinc (boiler plates), £27 ex-works; hard spelter and dross, £11 5s. delivered.

U.S. Steel Profits

The return on investment in the United States steel industry during the first half of 1939 was less than half the average return in the 10 years 1929-1938, and was only one-fifth as much as was earned in the 1919-1928 decade, according to the American Iron and Steel Institute. The industry's earnings during the half-year just closed represented 1.06 per cent. on capital investment, which compares with an average return of 2.4 per cent. annually over the decade 1929-1938, and with 5.1 per cent. in the 1919-1928 period. Net earnings of the industry after all charges, but before dividends, aggregated $25,450,000 for the half year. After payment of approximately $19,000,000 in cash dividends on preferred stock obligations, the net was reduced to $6,450,000. Approximately $55,000,000 in taxes were paid by the steel industry in the first half of this year, which was 20 per cent. larger than was paid in the corresponding period of 1938. The tax bill amounted to $3.70 for each ton of products shipped to customers of the industry during the half-year period. The total amount of dividends paid to the 519,000 stockholders of the industry represented 8 cents for each dollar going into the wages of the personnel employed by iron and steel producing companies.

Control of Employment

The Control of Employment Bill was given a second reading in the House of Commons on Tuesday. This Bill confers on the Minister of Labour extensive powers for controlling employment during the period of war. It provides that the Minister may make an Order directing:—

(1) That after the date specified an employer to whom the Order applies shall not, except with the consent of the Minister, publish any advertisement stating that he desires to engage any employee to whom the Order applies; and

(2) That after the date named such an employer shall not engage or re-engage any such employee unless consent to the engagement or re-engagement has been given by or on behalf of the Minister.

Control of British Shipbuilding

The Board of Trade has made Orders under the Defence Regulations affecting the shipbuilding and ship-repairing industries. The Orders provide that ships may be built or repaired in the United Kingdom only under the authority of a licence granted by the Board of Trade.

Licences will be required in respect of work at present in hand, but it is not intended that any such work should be suspended unless a notification to this effect is given by the Board of Trade. Shipbuilders and ship-repairers are, however, required to furnish to the Board of Trade full details of the merchant shipbuilding or repair work they now have in hand.

Economical Operation of Compressed-Air Plant

(*Concluded from page* 181.)

nation of certain operations in the past, over two-thirds of the present air demand was for air at about 30 lbs. pressure. The low-pressure cylinder of the compressors could comfortably cope with this, thus eliminating the second compression stage. After consultation with the manufacturers of the compressors, it was decided to change the high-pressure cylinders to the same size and type as the low-pressure cylinders. Both cylinders were then operated individually, both taking air from the atmosphere and both discharging into the same low-pressure receiver. The capacity of the compressor was thus practically doubled. The change was made on two compressors, with necessary piping and receiver alterations. A separate tank for the third compressor allows that to remain at the high pressure. The result is that all air demands, low and high pressure, are comfortably met with some margin available for any further works expansion.